THURSDAY, JUNE 26, 1873

THE ENDOWMENT OF RESEARCH

I.

THERE are not wanting signs that ere long the whole question of the present condition of research in this country, and of its amelioration, will undergo a complete discussion. Those who are best acquainted with this condition, and the position occupied by England at the present moment in the Science of the world, will be the first to acknowledge the importance of general attention being directed to the subject.

When the matter comes to be considered by minds free from the trammels alike of tradition and of prejudice, it will doubtless be found strange that such a fundamental question should have waited so long before it should have asserted itself; on the other hand, it is perfectly clear that many who are even now considering it have utterly failed to grasp it as it will have to be grasped.

This lack of clearness in the appreciation of the vast bearings of the question is quite pardonable, and is, doubtless, to a large extent, the natural consequence of the manner in which physical science has been added on to the older knowledge. It would seem, however, that a mere statement of a few fundamental positions should clear the view. These positions, most fortunately, are rapidly asserting themselves.

First, we have the generally acknowledged fact that a nation's progress depends upon its Science. Science, in fact, is the engine which must be as ever active in peace as the cannon's mouth is in war, and a nation may just as safely neglect one as the other.

This brings us to the second position. Does England as a nation pay as much heed to the one as the other? or as much as other nations? To ask this question is to answer it. England as a nation does next to nothing for this peace armament, and on all hands it is acknowledged that the nation's progress from this point of view is in great danger, because the decline of research in England, not only relatively, but absolutely, is so decided, that it is already a matter of history. We have long ago in these pages referred to Dr. Frankland's evidence on this point; he is the acknowledged head of chemical science in this country and should surely know; and other men who cultivate other sciences have expressed the same opinions with regard to them.

To what then is this decline to be attributed? The reply to this question brings us to the third point. There is absolutely no career for the student of Science, as such, in this country. True scientific research is absolutely unencouraged and unpaid. The original investigator is of course the man here intended, not the man who turns Science into a means of livelihood, however honourable, either as a teacher or a manufacturer.

There can be no doubt that to this state of things our present condition is to be ascribed, and this point is, according to us, the key of the whole position. A glance at the condition of things in France and Germany will strengthen our view. Why was Germany till lately the acknowledged leader in all matters connected with the advancement of knowledge? Because there were no such brilliant and highly paid careers open there as here to those who choose politics, the bench, the bar, or commerce, in preference to Science. And what is happening there at present? a decline visible not alone to the far-sighted, because Germany is getting rich as England has long been rich. Why is France now endowing research on a large scale, and even proposing that the most successful students in her magnificent Polytechnic School should be allowed to advance Science as State servants? Because in France there is a government instructed enough to acknowledge that a decline of investigation may bring evil to the State, and that it is the duty of the State to guard against this condition of things at all cost, this condition till lately, there as here, being that outside of the State service, and outside of the professoriate, no means of existence are provided for a student of Science; hence men of the most excellent promise are yearly lost to research, which undoubtedly also is the case with us.

What course then does it behove us to pursue in this country, in order that Science may take up its true position in our midst?

Here again opinion is rapidly forming itself. It is obvious to all who have thought about the matter, that it is absolutely indispensable that an employment, necessary for the public good, which is neglected to the State's detriment because in itself it does not bring in a livelihood, should be artificially supported, and artificially supported at the public expense. It would be quite justifiable, both from an economical and also a political point of view, to provide for the needs of knowledge out of the taxation of the country; because the taxpayer gets back his *quid pro quo* for the taxes he pays in the form of the amelioration of the conditions of living, as he gets it back in the form of security and good government.

It will probably be a considerable time before this truth is brought home to the public mind so completely as to render possible any large grant of national income for this purpose; but there are not wanting indications that statesmen of all parties are awakening to its reality, which in point of fact has long been conceded in principle. Still, such a source of support for Science to any very large extent must appear, even to the most sanguine, a thing of the future.

The area of knowledge will probably, in the future, increase beyond the means of any artificial support less than the national one; but perhaps it cannot be said that this state of things exists at present.

What, then, are we to do in the mean time? Have we no means which are at hand and immediately available, which may suffice to support the present claims of knowledge, without drawing too extensively upon the long-suffering or the intelligence of the taxpayer?

We have the means, if we will only employ them—nay more, some of them are now, for the most part, lying idle—of not only supplying all the needs of the physical and other sciences, but of supplying them magnificently. To mention no other sources of supply there is the Patent Fund, and the endowments of the colleges of the old Universities.

As to the Patent Fund, it is not too much to say that a

large part has been derived from the application of the abstract truths of physical science to the requirements of ordinary life, and that therefore the needs of physical science would be properly provided for out of it.

As to the College Endowments, whichever way we look at them, either as private bequests, as they are at length ceasing to be regarded, or as public funds, the conclusion is the same: their proper destination is the support of learning and Science.

If we look upon them as private bequests, and interpret the wills of founders and benefactors on the usual *ci-près* principle, we should be right in devoting to investigation of facts at first hand the funds which were left by the far-seeing men of the time of the revival of letters for the support of book-learning, which at that time occupied the place of modern Science. That they so regarded the aim of these bequests is shown, amongst other things, very remarkably by the universal annexation to the enjoyment of them of the condition of residence within the Universities. When the whole, or the major part, of the materials of investigation was enshrined in libraries, to insist that a man should remain where libraries were was to insist that he should remain in his workshop.

If on the other hand we are to regard these endowments as public funds, as is now generally agreed, is it right that such public funds should be consumed either in educating those who are practically as well able to pay for their own education as those who now receive a similar one at, say London University, an institution which is not aided by the State; or in supplying a life-maintenance to a considerable body of able young men, in return for passing a good examination at the outset of life?

It is well known that the ordinary Fellow of a college does not dream for a moment that he has any duties towards knowledge or Science. He regards the public money which he enjoys as a portion in a freehold estate, to enable him to tide over the uncertain years which come at the commencement of the ordinary professional career, the brilliant rewards of which we have shown to be the great cause of the decline of Science in this country, because they enable the practical life to outbid in attractiveness the laborious but most necessary pursuit of truth.

CHAUVEAU'S ANATOMY OF DOMESTICATED ANIMALS

The Comparative Anatomy of the Domesticated Animals. By A. Chauveau. Translated and edited by G. Flemming, Vet.-Surg. R.E. (J. and A. Churchill.)

FOR a long time there has been a great want felt by veterinary surgeons of a first-class work on the anatomy of the horse and other domestic animals, to be to them as valuable and trustworthy a book of reference as Quain and Sharpey's Anatomy is to the student of human anatomy. This feeling has induced Mr. Flemming to undertake the very arduous and considerable task of translating from the French the generally esteemed "Traité d'Anatomie Comparée des animaux domestiques" of M. Chauveau. The high position held by the Veterinary School of Lyons, and the great scientific reputation of its Professor, are sufficient guarantee for the excellence and accuracy of the original work before us, so that it will be unnecessary to enter into a detailed criticism of it: it will therefore be our chief duty to consider the manner in which the translation has been performed.

There are, however, one or two points to which we should like to draw attention in the work itself. First respecting the nomenclature of the lobes of the liver in the horse, Prof. Chauveau, as do most of the authors on the same subject, incorrectly calls the Caudate lobe the Spigelian. This error was clearly pointed out by Prof. Flower in his Hunterian Lectures last year, when he conclusively proved that the free, ear-shaped lobe, which is situated to the right of the vena portæ in the horse, rhinoceros and tapir, is the caudate and not the spigelian lobe. This last is represented by a long attached transverse ridge of hepatic tissue, situated further to the left. Again, it is not clear why the protometra is said to be incorrectly termed the *uterus mascululinus*, for it is certainly not a gland in the ordinary sense of the word, and is as certainly the rudiment of the duct which developes into the uterus in the female. In the paragraph on the small horny plates, called "chesnuts," found on the lower third of the inner face of the forearm and at the upper extremity of the inner face of the metatarsal bone of the horse, the author remarks that "In solipeds, the chesnut is the representative of the thumb." That such is the case is, to say the least, extremely doubtful particularly in any member of the class Ungulata; and from the fact that in the rhinoceros and tapir the second digit is perfectly developed, these epidermic appendages would be most probably larger in them than in Horse, if they represented the pollex and hallux; however they are altogether absent. That these horny plates in the fore-limb are situated above the carpus, is likewise not in harmony with their representing the thumbs.

Respecting the translation, which considering the size of the volume, must have been a very serious undertaking, the reader will, in the majority of cases, learn as correctly and as easily as from the original French. A perusal of several portions of the work seems to indicate that the translation has been performed by more than a single hand, for in some portions it is not so good as in others, and different words are employed to express the same one in the original. If there is any fault to find, it is one which may be considered by some to be rather an advantage than not, namely, that the rendering is too literal. A verbatim translation is in some cases not capable of giving the full force of the author's meaning in scientific as well as in other subjects, each language having an idiomatic phraseology of its own. For instance, the middle of the diaphragm may be correctly termed in French "le centre phrénique," but it is more than perplexing to comprehend at first sight what is meant by "the phrenic centre." The cavities of the heart (*les poches*) are not called "pouches" by English anatomists, and the colon is succulated (*bosselé*), not "bosselated;" this latter word is not to be found in some, perhaps not in any standard dictionaries. The stylo-glossus muscle does not "respond" (*il repond*) but corresponds "with the mylo-hyoid outwardly and the genio-glossus inwardly." The large colon of the horse is said to be fixed by adherence to the "cross of the cæcum;" we do not know what the cross of the cæcum is,

but the angle or bend (*crosse*) can be easily understood; in other places this word is correctly translated. Several minor errors in which nouns are rendered as adjectives and sentences are incomplete, will be no doubt corrected in a second edition.

Mr. Flemming has made some modifications in the general plan of the work, which will decidedly render it more useful to English readers. The descriptions of the anatomy of the ruminants, as well as those of the cat, dog, and birds, are in small type, so that it is not at all difficult, by omitting all but the large type, to study the bones, muscles, and nerves of the horse, without having to sift these out from the much larger mass of information respecting the other animals, as has to be done in the French edition. He has also added many notes, which in most cases bear on practical points in veterinary art; and he has omitted, wisely we think, the paragraphs of the original, which have reference to the dromedary and rabbit. Several of the unnecessary illustrations of human dissections, which can be found in many other works on the subject, have been omitted, and they have been replaced to advantage by others which further illustrate that of the horse, and also the recent advances in our knowledge of the structure of the tissues of the animal body.

Students of human anatomy are too apt to think that anthropotomy is the only subject of the kind which has been worked out thoroughly and in detail, but a glance at the book before us will soon remove that impression; and we are convinced that no one who has made any progress in a medical education could more profitably employ an occasional spare hour, than by a perusal of parts of this translation by Mr. Flemming of M. Chauveau's most excellent treatise.

RECENT ARITHMETICS

Arithmetic in Theory and Practice. By J. Brook-Smith, M.A., LL.B. (Macmillan, 1872.)

A Treatise on Arithmetic. By J. Hamblin Smith, M.A. (University Press, Cambridge, 1872.)

Figures made easy. A First Arithmetic Book. By Lewis Hensley, M.A. (Clarendon Press Series, Oxford, 1872.)

Notes on Arithmetic and Algebra. By the Rev. S. E. Williams, M.A. (Cambridge: J. Hall and Son, 1872.)

MOST persons engaged in tuition have often this critical question proposed to them, "Whose arithmetic do you recommend?" and as almost every teacher of mathematics fancies he has something new or varied to say on the subjects he has long taught, many rush into print, and thus submit their claims to consideration to a wider circle than that they have hitherto addressed. "As many arithmetics as teachers of the science," is perhaps as true a doctrine as that which applies to men and their opinions, certainly the writing of treatises on the subject has not of late years got into disfavour with the body referred to, and a second edition of De Morgan's Arithmetical Books, would show a considerable increase in number of authors if brought down to the present date. Every year sends forth a heap of candidates for the public favour. On the whole perhaps arithmetic has been very fairly treated; most of the treatises that have come under our own eyes have possessed something to recommend them. We have grouped together for our present consideration some of the most recent works on the science. Without doubt the first book on our list is entitled to the place of honour; it is, we think, the best work that has appeared for some years, the only work claiming to be ranked on the same high platform with it, being the "Arithmetic Theoretical and Practical," by W. H Girdlestone, M.A. (Rivingtons, 1870): the two have much in common. In this treatise the leading propositions are discussed and reasoned out in a lucid and accurate manner; the fundamental principles are clearly stated, and there is a valuable collection of examination papers for the student to try his powers upon. The writer is a disciple of De Morgan, to whom, as well as to other eminent writers on Arithmetic, he acknowledges his indebtedness. The book is quite up to approved modern standards, as it gives contracted methods of work, and treats of the metric system, and of the application of per-centages. It needs no further commendation, and after stating that it is a good *practical* work, we advise a student in want of a good treatise, to get this, and make it part and parcel of his mental furniture. The "get-up" of the book, its external dress, its inner garniture, is not merely neat but positively elegant, and possibly indicates the high interest the author takes in the subject upon which he has written so well.

Mr. Hamblin Smith's work calls for no special comment: the ability with which the author has written on other subjects will doubtless induce many to purchase the book. It is hard to write anything new on so hackneyed a theme, and there are few who have been able to raise the treatment of it above the ordinary fair orthodox level. We believe it to be a sound book, but it could have been dispensed with (especially with our first considered work in the field) except as it serves to fill up a niche in a connected series of text-books. The writer in this case also aims at teaching not so much *rules* as *principles*, and he rightly treats the so-called *rule of three* by the rational method now so generally adopted. The book may be recommended as a school-book, and this is probably the object the writer had in view. There is a copious collection of examination papers, which occupies nearly one-sixth of the whole work.

The third work on our list is concerned with much lower ground than the two former; it is written for mere infants, so to speak, in the science—it is an A B C: the receiving vessels are small and their capacity consequently for acquiring such new ideas as are presented to them at the outset of their inquiries also small; our author, with the ability only acquired by careful thought and experience, prepares right food, and not too much of that, for each lesson. In forty lessons the pupil is carried from "first notions of counting" to "division of fractions." With careful oral teaching we believe the book to be well adapted for the end aimed at. It is printed in the effective style of the "Clarendon Press" Series, and is further recommended by its cheapness.

The "Notes" presuppose a general knowledge of the subject, and give for the most part no explanation of the rules. The book is intended to act more as a "refresher" than as an "instructor," yet in the addition, multiplication, and division of recurring decimals, together with

the history of the calendar, the author has gone into a little more detail. To these "Notes" have been subsequently added some useful "Notes on Algebra." For the object aimed at the book is very fairly adapted. Some few further notes which will readily occur to the majority of teachers can be easily furnished to pupils using the "Notes" for insertion, in addition to the printed ones.

We have not tested the accuracy of the solutions given in the works we have here examined.

OUR BOOK SHELF

Official Guide-book to the Brighton Aquarium. By W. Saville Kent, F.L.S., F.Z.S. (Brighton, 1873, price 6*d.*)

THE Brighton Aquarium is without doubt the largest and most extensive of the buildings which have been erected of late years for the exhibition of aquatic animals. It also possesses the advantages of being at the seaside, and at the same time conveniently placed for access to the multitude of sight-seers. Though a large sum of money was spent upon its construction, we have been informed that good dividends are paid to the shareholders, and it would seem that the institution shows every symptom of favourable progress. In our eyes the issue of the present guide-book is a very welcome proof that Science will not be entirely neglected in the endeavours to attain material prosperity. Mr. Saville Kent's guide-book is drawn up with a strictly scientific method, but at the same time a large amount of popular information is given in it, and it is well adapted for the purpose for which it is intended.

The higher vertebrata of the Brighton Aquarium are at present but few in number, consisting only of porpois s, representing the order *Cetacea*, and the common seal, exemplifying the marine section of the Carnivora, and it is not likely that the representatives of these orders will be much increased in number. But the class of fishes is, on the other hand, very well represented, the Brighton Institution containing the best living series of these animals that has ever yet been brought together, and one that, as our weekly record of its progress shows, is continually increasing both in number and in variety. Mr. Kent's guide-book furnishes the visitor with a short account of the principal facts that are known concerning the life-history of each of these fishes, and cannot fail to add greatly to the instruction to be derived from a visit to the Aquarium. After the fishes, which certainly form the leading feature in the Brighton establishment, and consequently the principal topic in the guide-book, Mr. Kent turns to the Invertebrate division of the animal kingdom, and gives a general sketch of the five groups into which it is now usually separated, and of their principal representatives in the Aquarium. This portion of the guide-book, we think, requires further development, and will doubtless receive it in a future edition. We also beg leave to suggest that a few illustrations in the way of woodcuts would be a valuable addition to the handbook, and would, moreover, be likely to assist very materially in extending its sale. The only illustration in the edition now before us is the ground-plan of the building, given as a frontispiece to the work, and showing the arrangements of the different tanks and rooms. Figures of some of the more remarkable inhabitants of the tanks would, in our opinion, render Mr. Kent's book more attractive to the general visitors, and more useful to the scientific student.

Chemistry for Schools. By C. Haughton Gill. With 100 illustrations. Second edition. (London: Edward Stanford, 6 and 7, Charing Cross, 1873.)

MR. GILL's little manual is intended either for private study or for class-teaching, and has special reference to the requirements of those who have to learn the small modicum of chemistry required for the matriculation examination of the University of London. He has indicated the chapters necessary for the latter by a †, an act which we cannot at all approve. Surely, if even so light an examination as the one in question has to be undertaken in what may be to some a distasteful study, it is better to know too much than too little, and Mr. Gill's little book is not such a very dreadful treatise that one need be afraid of reading it through. If the examinations are to mean nothing more than the "getting up" of a set of special chapters written for the purpose, they had better by far be abandoned at once. With this exception we have little fault to find. Great care has been taken in arranging and systematising the work, though this has been pushed rather far—the word "acid," for instance, being almost banished. The great merit of the book is, however, to be found in the very admirably-selected questions placed at the end of each chapter: we feel sure that anyone conscientiously endeavouring to understand and work these out would learn more, and that more thoroughly, than he would by a vast amount of desultory reading and rambling through of larger works. We would say to any candidate for the London matriculation, "Let him neglect Mr. Gill's advice about the marked chapters, and work conscientiously through the book."

Report of the Rugby School Natural History Society for the Year 1872. (Rugby: Billington, 1873.)

WE are sorry that the first words of this Report are words of complaint at the small number of real workers among the numerous members of this society; some of the Sections we regret very much to be told, are either deserted or inactive. We hope no such complaint will be called for next year, and that the new regulation as to membership may be of service as a stimulus to work among the younger associates; by this new rule the number of members is henceforward limited to 15, for the purpose of making election to membership a real distinction. To judge from the number and value of the papers in the Report, there are, after all, not a few really good workers among the members. Of the various selected papers and reports one-half are by members who were actual pupils of the school at the time they were written. B. R. Wise's paper "On the Earliness of the Season" (1872), shows the possession of a power of observation which, if carefully cultivated, ought to produce good results. The same may be said of A. G. Burchardt's paper on "The Work of the Anatomical Section," which contains an account of some of the animals found in the Rugby district, and some very useful directions on the preservation of specimens. E. J. Taylor's account of "A Visit to Norway" is interesting, and shows the author can make use of his eyes. L. Maxwell's essay on "Spectrum Analysis," well deserves the Society's Prize, which was awarded to it: the author shows that he possesses a clear idea of the nature of Spectrum Analysis, the principles on which it is based, and the many valuable purposes it is calculated to serve. It is accompanied by some rough but intelligible drawings of various absorption spectra. The second prize was awarded to an intelligent paper by H. N. Hutchinson on "Motive Power," in which the author describes and illustrates various substitutes for coal as generators of motive power, including an ingenious flux motor, or tidal engine. Among other interesting papers we would mention the valuable observations on *Hippocampus brevirostris*, by the Rev. T. N. Hutchinson; and some very curious facts as to protective mimicry in spiders, communicated by the Rev. C. W. Penny. From the Astronomical Report, by Mr. Wilson, we learn that a large amount of good work is being done, especially in solar observation. Appended to the report are Messrs. Lockyer and Seabroke's paper "On a New Method of Viewing the Chromosphere;" and a report on the November Meteors, by L. Maxwell. The Meteorological Observations seem to have been regularly and carefully taken, though we hope there will be more to report in the

Zoological Section as the result of the present year's work; the anatomical department of this section has, however, made a fair start under the direction of the late member, Mr. A. G. Burchardt. W. B. Lewis's Report of the Geological Section, with accompanying plates, shows there has been some activity in this department. A. F. Buxton's Entomological Report consists of a complete list of the Lepidoptera which have been noticed within eight miles of the School Close. Under Mr. Kitchener's, the President's, guidance, some good work has been done in the Botanical Section, though the workers seem to be few. Appended to the report of this section is an abstract of two papers by Mr. Kitchener on a Pelerian form of *Linaria vulgaris*. On the whole, the Report of this Society's work for 1872, is one of which there is no reason to be ashamed, and we hope that each year will add to the number of those who take an active part in the work. From many scientific societies it is not advisable nor often expedient to exclude non-workers, but in such societies connected with schools, it should be insisted on that every member be an active worker: only thus can they completely serve the purpose for which they are established.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Dr. Sanderson's Experiments and Archebiosis

THE letter by Dr. Sanderson, in last week's NATURE, contains an interesting and important confirmation of my experiments, which I was very glad to see. There are two or three points, however, which seem to require some comment.

In the first place the flasks and retorts after exposure to the heat were kept only from three to six days, before they were submitted to examination in order to ascertain whether fermentation had or had not taken place. But in cases in which fluids are exposed to heat for a long time, or are exposed to higher temperatures, the process of fermentation is almost invariably delayed and also modified in intensity. It must not therefore be supposed that fermentation would not have taken place at all in certain of Dr. Sanderson's flasks, simply because it had not occurred within four, five, or six days.

Secondly, Dr. Sanderson thinks his present experiments enable him to say that the particular fluid with which he experimented is not prone to undergo fermentation within six days, after it has been heated to a temperature of 100·92° C. I would ask Dr. Sanderson, however, whether he has been careful to observe the precise temperature attained by an infusion boiling rapidly in a flask from which the steam can find exit only through a capillary orifice—as in the experiments which we performed together?

Thirdly, I think it very desirable that Dr. Sanderson should state definitely to the scientific world what precise meaning he wishes to convey by his emphasized use of the word "*chance*" in the concluding paragraph of his letter. There seems a little ambiguity in his use of the word, which is the more to be regretted, since it occurs in the statement of an inference—where freedom from all possibility of misconception is so eminently desirable. H. CHARLTON BASTIAN

University College, June 23

Spectrum of Nitrogen

IN a letter to NATURE (April 17th), Mr. Stearn throws some doubts on the accuracy of my experiments regarding the spectrum of nitrogen. I shall take the earliest opportunity of repeating and completing my experiments, and hope then to bring the question to a satisfactory close. As, however, some time may elapse before I can resume work, I wish to say now a few words in answer to Mr. Stearn's letter.

Before all, I wish to state clearly in what way the correctness of the opinion I profess with regard to the band-spectrum of nitrogen would be affected by an error introduced into my experiments. The unexpected result of an experiment of mine, together with a remark which Plucker makes in one of his papers, suggested to me the idea that the so-called band-spectrum of nitrogen might be that of the oxides of nitrogen. I was confirmed in this idea soon afterwards by a remark of Angström in his recent paper on double spectra (*Comptes Rendus*, August 17, 1871, but which was omitted in the English translation), by which he calls attention to the close resemblance of this band spectrum with the spectrum of metallic oxides. I have described in my paper the experiment just mentioned. A rather narrow tube showed, when exhausted, the lines of nitrogen; as soon as the air entered the bands appeared. The remark of Plucker alludes to the fact that a tube filled with oxides of nitrogen showed the bands with unusual brilliancy. In order to test the accuracy of this opinion I intended to make a crucial experiment by taking care to remove every trace of oxygen. I used for this purpose, at the suggestion of Dr. Balfour Stewart, small pieces of sodium heated in the vacuum tubes. The sodium was fused several times in succession in order to free it from impurities. When the nitrogen was thus treated it always showed a line spectrum, the lines of which seemed to coincide with those of the known line spectrum of nitrogen when measured with the instrument at my disposal. It seems now that I have been too hasty in assuming that this apparent coincidence was a real one. While passing through London a few weeks ago, Dr. Huggins was kind enough to allow me the use of his spectroscope in order to compare, under his supervision, the spectrum of my tubes with the real line spectrum of nitrogen. I then found that, although my tube shows a line which is very near the principal double line of nitrogen, the spectrum is not that of nitrogen. I am at present unable to say what is the origin of this spectrum; but I do not think that its formation can be brought forward as a proof that the band spectrum is not due to oxides of nitrogen. On the contrary, it rather shows that an impurity which has no effect on the spectrum of air, will have one when all the oxygen is removed, and that a change has therefore probably taken place in the conducting power of the gas which gives out the spectrum.

I do not quite see the real object of Mr. Stearn's letter. If he merely wishes to say that the proof brought forward by me is insufficient, and that the question must still remain an open one, I confess I have nothing to say against it. If he, however, wishes to convey the idea that nitrogen has really a double spectrum, I do not think his argument is a correct one.

I will not trespasss any longer upon your space, but I may, I think, fairly ask your readers to suspend their judgment until I have completed my experiments.

Heidelberg, May 30 ARTHUR SCHUSTER

Ground Ivy

WITH respect to the question started in the number for June 12 of this journal as to the Ground Ivy, it may be said that in *Glechoma*, as also in *Origanum vulgare*, *Thymus serpyllum* and *vulgaris*, and *Mentha vulgaris*, specimens having flowers with small corolla and undeveloped anthers are very common, I think as common as specimens having flowers with large corolla and the two sexes developed. Also of *Mentha aquatica* and *Prunella vulgaris* specimens with smaller corolla and only pistils developed are found, but much more rarely than those of the other form.

I have attempted in my work to give an explanation of the origin of the second form of the above-mentioned Labiatæ, as follows:—

The species named are distinguished from our other Labiatæ by the coincidence of the following three peculiarities:—

1. By an abundance of honey, and in consequence of that by an abundance of insects visiting and cross-fertilising them.*

2. In the hermaphrodite flowers, by a stigma so far overtopping the anthers and developed so long after the anthers that self-fertilisation is impossible, or nearly so.

3. By a great variability in the size of the corolla in the hermaphrodite flowers of different specimens.

Now when the flowers on different stems of the same species differ in the size of their corolla, it is evident *a priori*, and ascertained by direct observation, that generally those with the largest corolla are the first seen and visited by insects flying near them, those with the smallest corolla the last. The latter, always the flowers last visited, are fertilised exclusively by the pollen of previously-visited flowers, consequently produce their pollen in vain; and since the non-production of useless organs is always an advantage to every organic being, varieties of the smallest

* For instance, I found *Thymus serpyllum* visited by 7 species of Apidæ, 3 species of *Sphegidæ*, 14 species of Diptera, and 6 species of Lepidoptera; *Glechoma* visited by 21 species of Apidæ, 8 species of Diptera, and 3 species of Lepidoptera.

flowered form must be favoured in the struggle for existence, when ceasing to develop their useless anthers. Thus of the smallest-flowered form, varieties with atrophied anthers of necessity remained at last the only survivors.

Lippstadt, June 17 H. MÜLLER

ALL the flowers of the ground ivy (*Nepeta Glechoma*) that I have this season examined, from this neighbourhood, have been of the stamenless form described by your correspondent "S. S. D." While spending a few days at Bath, I could find none but hermaphrodite flowers. At Hertford I found both forms, but a preponderance of hermaphrodites. These seem always more or less protandrous, and spontaneous self-pollenation is further prevented by the unequal lengths of the style and stamens.

Kilderry, Co. Donegal W. E. HART

Lotus corniculatus

MR. W. E. HART (NATURE, June 12) is quite right in correcting me on the subject of the fertilisation of *Lotus corniculatus*. It is the outer whorl of stamens, those opposite the calyx teeth, which continue to grow after the others, and which have their filaments dilated at the top so as to thrust the pollen out of the long sharp tube of the keel. I should scarcely have thought it necessary to acknowledge his courteous correction, if it were not for the following question and answer: How is it, then, that the pollen of the inner and shorter whorl of stamens, which discharge their pollen at the same time as the outer whorl, gets pushed out by the filaments of the outer whorl, since the anthers of the inner whorl lie below the summits of the filaments of the outer whorl? The answer is curious: In the early bud, before the anther cells begin to open, the inner whorl is obviously shorter than the outer whorl, so that the anthers of the former lie in a regular row entirely below the anthers of the latter, apparently for the convenience of close packing in the narrow closed flower. As the anther cells begin to open, which is just before the flower opens, the stamens of the inner whorl grow and approach very nearly in height to the stamens of the outer whorl; and as they shed their pollen from the summit of the anthers, their pollen comes out above the dilated tops of the filaments of the outer whorl, so that it can be pushed forwards by those filaments along with the pollen of their own anthers. The filaments of the inner whorl then wither and become comparatively short, while those of the outer whorl continue to grow, dilate, and stiffen, so as to do the work for all the pollen of both whorls. In the mature opened flower the difference between the two whorls becomes more marked than ever. If I am right, Mr. Hart's detection of my blunder leads to the notice of a curious instance of economy of space and of mechanism. T. H. FARRER

Abinger, Surrey, June 21

The Secchi and Respighi Methods

IN the number of NATURE for June 12, p. 136, I see that you notice the results obtained in the last eclipse with the use of the spectroscope for determining the first entrance of the moon or planet. There seems, however, to be some confusion in the report. You say that I propose Respighi's method for first contact, and my own for the last. This is not the case. I propose the common Respighi method as useful for obtaining a *first warning* of the entrance of the planet on the chromosphere. This is the only use I think it possible to make of it. But the real entrance must be obtained by my method, in which one sees the disc of the sun as with a common glass, and the line of the chromosphere tangent to it, can be seen broken at the instant of contact, as the ring of Venus is broken at its exit from the solar disc.

You say also (page 131, col. 1) that it is difficult to obtain a perfect adjustment on account of the inequality of the driving-clock. If you say so for the common spectroscopic method, I agree perfectly with you, because the edge of the disc cannot be seen; but with my method this difficulty does not exist. It is not more difficult to keep the sun's disc tangent to the chromospheric line, than to keep it tangent to a common wire; the clock can help, but it is not necessary to have it in perfect order; even with common handles one can obtain it. The reason is that the solar disc being perfectly visible, one is greatly helped by the edge of the sun itself, while in common methods the edge of the sun is not seen.

Rome, June 16 P. A. SECCHI

P.S.—More on this will be found in the *Memorie del. Soc. degli Spettroscopisti Ital.*

Gassendi and the Doctrine of Natural Selection

NO one having yet replied to the question in Mr. Monro's letter (see NATURE, vol. vii. p. 402), I venture to hope that you will give me space for a few remarks on Gassendi's physical philosophy, and more especially on that part of it germane to the subject discussed by Mr. Monro.

The apparent implication of the question referred to is, that anticipations of natural selection are to be found in Gassendi's writings. Allowing to the term its utmost latitude of meaning, this does not appear to me to be the case. In his historical sketch of the various views which poets and philosophers have held as to the origin of things, Gassendi gives the theory of Empedokles at some length, including the passage on the βουγενῆ ἀνδρόπρωρα which Mr. Monro quotes in his letter. But Gassendi has no word of approval for the theory; he classes it with other Greek cosmogonies, such as those of Anaximander, Pythagoras, &c., and with the Chinese and Hindu cosmogonies as "fabulares sententias philosophorum," not less fabulous indeed than the poetic fictions of Prometheus, Deukalion, and Kadmus. Here, too, as well as in other parts of his works, Gassendi blames philosophers for ascribing to the action of natural laws effects which he regards as direct results of the Divine power.

Before giving a brief summary of Gassendi's own views, I will premise that it is not easy to discover them with exactitude. His works are very voluminous. both the Lyons edition of 1658, and the Florence edition of 1728, occupying six bulky and closely printed folio volumes. Even the abridgment made by his disciple Bernier fills seven vols. 12mo. Ordinary histories of philosophy give for the most part a very meagre account of the French forerunner of Locke; and more comprehensive works, like those of Tennemann, Buhle, and De Gerando, deal with Gassendi as a psychologist and a moralist rather than as a physicist. Even Dr. Whewell, from whom, as the historian of the inductive sciences, more might have been expected, makes but a few cursory references to the philosopher who was one of the earliest and most pronounced followers of the Baconian method, and who, as De Gerando says, "enseignant les mêmes principes (as Bacon) les a surtout enseignés par son exemple." The work which, as far as I have seen, gives the most complete account of Gassendi as a physical philosopher is Schaller's "Geschichte der Naturphilosophie von Baco bis auf unsere Zeit." This writer takes Bacon, Hobbes, and Gassendi as the typical philosophers of the empirical or *a posteriori* school of natural philosophy. He devotes about one hundred pages to the exposition of Gassendi's physical doctrines, and concludes with an elaborate criticism of his atomic theory. The intrinsic obstacles to a precise appreciation of Gassendi's views are more serious. Not far removed from the age of scholasticism he exhibits, in a modified degree, two of the distinctive features of the schoolmen, their pedantic erudition, and their commentatorial spirit. The wealth of quotation with which his pages are burdened rather than adorned has laid him open to the charge "de laisser étouffer ses propres idées sous le poids des citations empruntées aux anciens." He better deserves the second than the first clause of Gibbon's epigrammatic eulogy: "Le meilleur philosophe des littérateurs, et le meilleur littérateur des philosophes." A work largely imbued with the commentatorial spirit, as the *Syntagma Philosophicum* is, is always more valuable as a history of philosophic opinion than as a source of new philosophic thought. Again Gassendi's bent of mind, coupled with the exigencies of his position as a Church dignitary, seems to me to have precluded his holding opinions of a very decided and novel character. True or not, the reason he is said to have given for adopting the atomism of Epicurus rather than the Cartesian theory of vortices is somewhat characteristic; "Chimæra for chimæra I cannot help feeling some partiality for that which is two thousand years older than the other."

In his views as to the origin of things, Gassendi is at once an atomist and a special creationist. One experiences a certain sense of incongruity in noticing the way in which, while following the Biblical narrative for the main outlines of his doctrine, he fills in the details from Atomism. In the beginning there was a chaos in which the Deity had intermingled in manifold confusion atoms, molecules, *corpusculæ insectiliæ*, or *minima naturalia* (a phrase borrowed from Lucretius) of every kind, celestial and terrestrial, organic and inorganic, animal and vegetal. Upon these atoms had been impressed peculiar motions and affinities. At the creation of the world, as the creative fiats in their turn went forth, the potential motions and affinities of each species of atom became kinetic, and by the concourse of

atoms, similarly endowed, the successive stages of creation were accomplished. There is so much resemblance between Gassendi's account of the appearance of the different animal forms, and the Miltonic narrative of the time when "the grassy sods now calved," that the question suggests itself whether the "Paradise Lost," which appeared in 1667, might not have been influenced by the *Syntagma Philosophicum*, its predecessor by some twenty years? From the side of Atomism Gassendi seeks to explain the Divine cessation from labour after the six stages of creation. Besides the atoms which, when endowed with kinetic energy, gave rise to the primordial plants and animals, there remained others in which their characteristic motions and affinities still continued potential, and which had been subject to distribution only. These account on the one hand for the seminal reproduction of plants and animals, and on the other for the phenomena of so-called spontaneous generation. On this view, as may be supposed, spontaneous generation presents few difficulties to Gassendi. He needs but the hypothesis of the endurance from the creation of the atoms special to any peculiar form of life. Then, when their potential motions and affinities become kinetic, they must of necessity issue in the forms of life which by their concourse they were destined to produce. Two points are worthy of notice in this connection—Gassendi's definition of spontaneous generation, and his list of animals produced spontaneously. Spontaneous generation is not generation "sine seminibus" (germs), but "sine parentibus." Amongst his "animalia sponte nascentia" are enumerated "mures, vermes, ranæ, muscæ, aliaque insecta."

In a theory such as this is there no evolution, no selection. The atoms themselves are unchangeable, and so are the specific characters of the aggregates which they build up. Plants and animals, as they now are, are but copies of the primitive forms, be they produced by gamogenesis or spontaneously. The natural conditions also by which floral and faunal habitats and distribution are regulated, Gassendi seems to regard as having been fixed once for all at the creation. Reading "Deus" for "Natura," Virgil's lines express Gassendi's views on this point—

> "Continuo has leges, æternaque fœdera certis
> Imposuit Natura locis."—(Geo. i., vv. 60, 61.)

There is a sort of superficial resemblance between Gassendi's atoms and Mr. Spencer's "physiological units," but with capital points of difference. In both theories the molecules of each species of plant and animal have distinctive characteristics, and an inherent power of arranging themselves in the form of the organism to which they appertain. But while Gassendi's atoms are simple and indivisible, as one of their synonymes, *corpusculæ insectilæ*, connotes, Mr. Spencer's physiological units are complex. While Gassendi's atoms are specific creations and endowed with unalterable properties, Mr. Spencer's physiological units are themselves the products of evolution, and are perpetually undergoing adaptation to equilibrate the action of forces internal and external.

I am inclined to suspect that Maupertuis may have, in the main, borrowed the atomic theory contained in the "Système de la Nature" from Gassendi. The materialism which led Maupertuis to make perception a fundamental property of his atoms is, however, all his own; at any rate it is not Gassendi's.

In Physics as in Ethics, the nearest affinity of the philosophy of Gassendi is to that of Epicurus. It is Epicurianism modernised, and modified so as not to clash, openly at least, with Christianity and with the dogmas of the current theology. By his want of originality he was led to base his philosophy on an already established system, and by his adoption of Bacon's method he was attracted to Epicurus, for that philosopher and his school were the sole ancient representatives of the new *a posteriori* philosophy. De Gerando thinks that an additional link between Gassendi and Epicurus existed in the similarity of their views on the physical doctrines of a vacuum and of atoms. But it seems at least as probable that the French philosopher adopted these conceptions from the Greek, as that he reached them by his own independent thought. While, however, he was essentially an Epicurean, Gassendi was careful not to commit himself to any doctrines which might cause his orthodoxy to be questioned; in fact, he more than once clearly expresses this determination.

"How far back can traces of the great theory of Darwin and Spencer be discovered?" As I showed in my letter on Maupertuis, in NATURE, vol. vii. p. 402, the doctrine is discoverable in that writer; but De Maillet, with whom Mr. Spencer begins his historical sketch, is a quarter of a century earlier than Maupertuis. My examination of Gassendi leads me to the conclusion that the doctrine of Natural Selection is not to be found in his works, and further that his views, as far as I understand them, effectually preclude his holding the theory under any form.

W. H. BREWER

P.S.—On looking back over what I have written, I find that I have omitted to point out the different attitudes of Gassendi towards the two distinct portions of his cosmological views. When he is borrowing from the Mosaic account of the creation, all his assertions are positive, for here we have "quod Fides et Sacræ Literæ docent." When, however, he is borrowing from Atomism his views take a hypothetical form, and are introduced by the phrase "nihil vetat supponere."

Grace's Road, Camberwell

Care of Monkeys for their Dead

As a supplement to the extract from James Forbes' "Orienta Memoirs," given by Dr. Gulliver in NATURE (vol. viii. page 103), the following incident, recorded by Capt. Johnson, deserves republication :—

"I was one of a party at Jeekarry, in the Bahar district; our tents were pitched in a large mango garden, and our horses were picqueted in the same garden at a little distance off. When we were at dinner, a Syce came to us complaining that some of the horses had broken loose in consequence of being frightened by monkeys (*i.e. Macacus Rhesus*) on the trees. . . As soon as dinner was over, I went out with my gun to drive them off, and I fired with small shot at one of them, which instantly ran down to the lowest branch of the tree, as if he were going to fly at me, stopped suddenly, and coolly put his paw to the part wounded, covered with blood, and held it out for me to see. I was so much hurt at the time that it has left an impression never to be effaced, and I have never since fired a gun at any of the tribe.

"Almost immediately on my return to the party, before I had fully described what had passed, a Syce came to inform us that the monkey was dead. We ordered the Syce to bring it to us, but by the time he returned, the other monkeys had carried the dead one off, and none of them could anywhere be seen."

G. J. R.

The Intellect of Porpoises

IN Prof. Huxley's admirable criticism of "Mr. Darwin's Critics,"* the following passage occurs :—"The brain of a porpoise is quite wonderful for its mass, and for the development of the cerebral convolutions. And yet, since we have ceased to credit the story of Arion, it is hard to believe that porpoises are much troubled with intellect."

I have no doubt that Prof. Huxley will agree with me in further concluding that "it is hard to believe" that the remarkably developed cerebral hemispheres of the porpoise with their deep and numerous convolutions perform no more exalted functions than the smooth pair of mere pimples that stand behind the olfactory ganglia of a cod-fish, and constitute the whole of his claim to a cerebrum proper.

The psychology of the porpoise (and also that of the dolphin and other cetaceans with similar brains) is thus a subject of primary interest to the student of cerebral physiology. As a contribution to the subject I offer the following facts :—

Many years ago I made the voyage from Constantinople to London in a small schooner laden with box-wood, &c. The passage was very slow, occupying fully two months, including the whole of August, and parts of July and September. We were often becalmed, with porpoises playing about the ship. The sailors assured me that no sharks were in the neighbourhood while the porpoises were near, and accepting this generalisation I frequently plunged overboard and swam towards the porpoises. They usually surrounded me in a nearly circular shoal or company, and directed towards their unusual visitor an amount of attention which I may venture to dignify with the title of curiosity. Their respiratory necessities precluded any long-continued scrutiny, but after dashing upwards for their customary snort, they commonly resumed their investigations, sometimes approaching uncomfortably near and then darting off to the circumference of the attendant circle. I am not able to describe the expression on the *features* of a porpoise, but my recollection of that of the eyes of my swimming companions is very different

* *Contemporary Review*, 1871. Reprinted in "Critiques and Addresses."

from what I have since seen on the large vacant orbs of aquarium cod-fishes, &c.

I have not yet seen the porpoises in the Brighton Aquarium, but suspect that if they contrive to "make themselves at home" there, a careful study of their habits will remove some of the difficulty which Prof. Huxley experiences in believing in their intelligence. W. MATTIEU WILLIAMS

Instinct

A DIFFICULTY occurred to me on reading Mr. Lewes's interesting and instructive article on "Instinct" in NATURE of April 10—and as no satisfactory answer offers itself to me, I venture to trouble you with it.

Wherein lies the difference in kind between the actions performed instinctively by animals for the preservation of themselves or their young, and those actions performed by plants with the same result?

For instance; the Ivy Linaria grows on an old wall; its flowers and the flower-stalks stand out for the sun and insects to visit the little "snap-dragon." But no sooner does the corolla fall, than the peduncle begins to curve inwards to the wall, and usually contrives to tuck its seed-vessel well into the brickwork again. We cannot say of such an action that there is "no alternative open to it;" and even if we do, it does not explain it to call it "impulsive," and yet one is not prepared to accept it as an instance of instinct. I shall be grateful for any elucidation. M.

Grus vipio

I OBSERVE that in your report of the meeting of the Zoological Society on the 6th ult., in your issue of the 15th, it is stated, with reference to *Grus vipio* (*seu leucauchen*), that "no example of this fine species, so far as was known, had previously been brought alive to Europe." Last autumn, when going over the Zoological Gardens at Amsterdam with the superintendent, Mr. Hegt, I saw there a splendid pair of these birds, which had been purchased for 140*l.*, and had bred the same spring, and reared successfully a fine young bird, about two-thirds grown when I saw it in September, destined, as I was informed by Mr. Hegt, for the Berlin Gardens. The collection of cranes at Amsterdam is exceedingly rich, far surpassing either London or Antwerp in this respect. It contained, when I saw it, fourteen out of the fifteen valid species of Grus, comprising, besides the above-mentioned, *G. vipio*, a splendid pair of *G. viridirostris*, a fine *G. leucogeranus*, *G. carunculatus*, *G. canadensis*, *G. Americana*, *G. torquata*, &c., the desideratum being *G. monacha*, of Japan.

W. A. FORBES

Culverlea, Winchester, June 2

ON THE SYNTHESIS OF MARSH-GAS AND FORMIC ACID, AND ON THE ELECTRIC DECOMPOSITION OF CARBONIC OXIDE *

IN connection with the investigation on the electric decomposition of carbonic-acid gas referred to in a previous communication to the Society, I was led to submit a mixture of hydrogen and carbonic-oxide gas to the action of electricity in the induction-tube, the mixed gases being circulated through the tube by means of an apparatus which I will not now describe. A contraction was soon observed to have taken place, which at the end of an hour amounted to 10 cub. centims. The rate of contraction steadily diminished, and during the fifth hour of the duration of the experiment amounted to only 2 cub. centims. The experiment was stopped, and the gas analyzed with the following results in two several analyses:—

	I.		II.
Carbonic oxide	61·65	Carbonic oxide	61·35
Hydrogen	32·16	Hydrogen	32·34
Marsh-gas	6·14	Marsh-gas	6·31
	100·00		100·00

A small quantity (about 2 per cent.) of nitrogen was also contained in the gas, together with a trace of oxygen, which have been omitted from the calculation.

The result of this reaction is expressed in the following equation:—

$$CO + 3H_2 = CH_4 + H_2O.$$

This fundamental experiment, which constitutes the basis of a new method of chemical synthesis, susceptible of the most varied applications, and of peculiar interest in reference to the explication of natural phenomena, was commenced by me on the 10th of January last at Oxford, in the laboratory of my friend and successor in the Chair of Chemistry, Prof. Odling; two analyses of the gas were completed, and the results attained in the course of a week from that date. In a similar experiment made with a mixture of hydrogen and carbonic-acid gas, a contraction also occurred, attended with the formation of water. The gas which resulted from the experiment was found to consist (after the absorption of carbonic acid) of hydrogen and carbonic oxide, together with a little marsh-gas. Traces of oxygen and nitrogen were also present. Minute drops, too, of an oily liquid appeared in the tube. This liquid, after the conclusion of the experiment, was dissolved in a small quantity of water. The solution was strongly acid and had a pungent taste. It reduced an alkaline solution of terchloride of gold and an ammoniacal solution of nitrate of silver. These reactions are the characteristic properties of formic acid, of which we may infer the synthesis to have been effected according to the equation

$$H_2 + CO_2 = H_2CO_2.$$

I may avail myself of the present opportunity to place on record the following important facts in reference to the action of electricity on carbonic-oxide gas.

When pure and dry carbonic oxide is circulated through the induction-tube, and there submitted to the action of electricity, a decomposition of the gas occurs, attended with a gradual and regular contraction, which, in the form assumed in my experiments, occurred at the regular rate of about 5 cub. centims. in an hour. Carbonic acid is formed, and simultaneously with its formation a solid deposit may be observed in the induction-tube. This deposit appears as a transparent film of a red-brown colour, lining the walls of the tube. It is perfectly soluble in water, which is strongly coloured by it. The solution has an intensely acid reaction.

The solid deposit in the tube, in the dry condition before it has been in contact with water, is an oxide of carbon. Samples, however, made in different experiments do not present precisely the same composition; but nevertheless they appear to belong to a certain limited number of forms which repeatedly occur, and may invariably be referred to the same general order or system. This system is, or appears to be, what I may term a homologous series of "oxycarbons," of which the unit of carbon with the weight 12 may be regarded as the first term, and of which the adjacent terms differ by an increment of carbonic oxide (CO) weighing 28, precisely as homologous series of hydrocarbons differ by the increment CH_2 with the weight 14. I have succeeded in identifying by analysis two at least of these substances, namely, the adjacent terms C_4O_2 and C_5O_4. From this point of view these peculiar bodies are members of a series of oxycarbons analogous in the oxycarbon system to the series of hydrocarbons of which the unit of carbon is the first and the unit of acetylene C_2H_2 is the second term, the oxycarbon C_4O_3 being represented in that series by the hydrocarbon crotonylene C_4H_6, and the oxycarbon C_5O_4 by the hydrocarbon valerylene C_5H_8.

* A paper read at the Royal Society by Sir B. C. Brodie, Bart., D.C.L., F.R.S., late Waynflete Professor of Chemistry in the University of Oxford.

THE LAW OF STORMS DEVELOPED *
III.

FROM the Cape of Good Hope, in a straight line toward the projecting eastern coasts of Brazil, mariners have found a peculiar streak of south-easterly winds.

* Continued from p. 148.

Between the island of Tristan da Cunha and the Cape, and northward and westward to the island of Fernando Noronha this streak of powerful winds, with which nothing in the trade-wind region of the North Atlantic can compare, has its atmospheric current as sharply marked as the dark blue and rapid current of the Gulf Stream in the Narrows of Bemini. It is, doubtless, the region or band of most intensely acting south-east trades, and is probably due to the peculiar configuration of the shores of the South Atlantic, and to the wall of the South American Andes. It is a well-known fact that the volcanic cone of Teneriffe, which lies in the zone of north-east trades, intercepts the wind and gives it a lateral deflection; so that, while the trades are blowing strongly on the north-east side of the island, on the opposite side there is a distinctly-marked and carefully-measured calm shadow. Now, the chain of the Andes endeavours to exert on the south-eastern trades just such an influence as is exerted by the Canary Islands on the north-east trades. This influence, in the former case, suffices to throw off from the Continent of South America a large body of the south-east trades, and to deflect it to the eastward, giving it the character of a south-south-west wind, and, at the same time, by forcing a greater or more concentrated body of air into the regions north-east of Brazil, imparting an increased velocity and violence to the air-current. It is, therefore, in the air-current that the homeward-bound vessel from the Cape of Good Hope aims to steer, because she is sure of being wafted happily and swiftly to her destination.

It has long been demonstrated by meteorologic observations, taken both at sea and on land, that there is very much *less* atmosphere in the Southern Hemisphere than in the northern, and for a long time physicists were at a loss to account for the difference. It has been, however, very satisfactorily explained by the eminent American mathematician, Ferrel, in his work on the "Motions of Fluids and Solids, relative to the Earth's Surface," where he proves at length, and states in detail (p. 39): "As there is much more land, with higher mountain ranges, in the Northern Hemisphere than in the southern, the resistances are greater, and consequently the eastward motion of the air, upon which the deflecting force depends, is much less; and the consequence is, that the more rapid motions of the Southern Hemisphere cause a greater depression there, and a *greater part of the atmosphere to be thrown into the Northern Hemisphere.*" It is, doubtless, to this tendency of the Southern Hemisphere to throw off much of its atmosphere north of the equator that we may attribute in part the superior force and power of the south-east trades, and their well-known ability to battle with the north-east trades, and drive them from their own territory, at least all summer, and even in winter, as far back across the line as 3° or 4° north latitude. Mr. Ferrel, speaking of the principle just enunciated, well says: "This also accounts for the mean position of the equatorial calm-belt being, in general, a little north of the equator. But, in the Pacific Ocean, where there is nearly as much water north of the equator as south (and the resistances are usually equal), its position nearly coincides with the equator." In other words, just as a bucket full of water revolving on a perpendicular axis would show a depression in the centre, and the fluid be thrown from all sides of its rim, the Southern Hemisphere throws its water and its atmosphere into the Northern hemisphere, all along the equator.

It is, therefore, a mathematical and mechanical certainty that there is an invasion of the north-east trade-wind belt from the south-east trades, and observation powerfully bears out the deduction of the mathematician. Ansted states in his cautiously-written "Physical Geography:"—"The southern trade-wind region is much larger than the northern in the Atlantic Ocean. In this sea, the south-east trades are fresher, and blow stronger, than the others, and often reach to the 10th or 15th parallel of north latitude; whereas the northern trade-wind seldom gets south of the equator, and usually ranges from 9° to 29° north latitude" (p. 253). It is not difficult to see how easily it happens that a very small atmospheric eddy found in the tropical Atlantic by the conflictory north-east and overleaping south-east trade-winds may soon become a hurricane of wide extent and of tremendous energy. All that is necessary, as we have before seen, is that an initial impulse of gyration be given to a body of air. The moment that this takes place by mechanical influence, and centrifugal force creates the smallest eddy or vortex, the surrounding air, already highly charged with moisture, begins the process of convergence and ascensional motion, followed rapidly by condensation aloft.

The storm-cylinder—the nucleus of the hurricane—originally very small, is instantly enlarged and expanded by the evolution of latent heat stored away in the vesicles of aqueous vapour. For some hours, as all observations show to be actually the case, the incipient cyclone scarcely moves, while gathering in its energies and laying tributes upon all contiguous regions. The process continues with momentarily increasing intensity, and, before the sun has made his daily circuit, the meteor is formed.

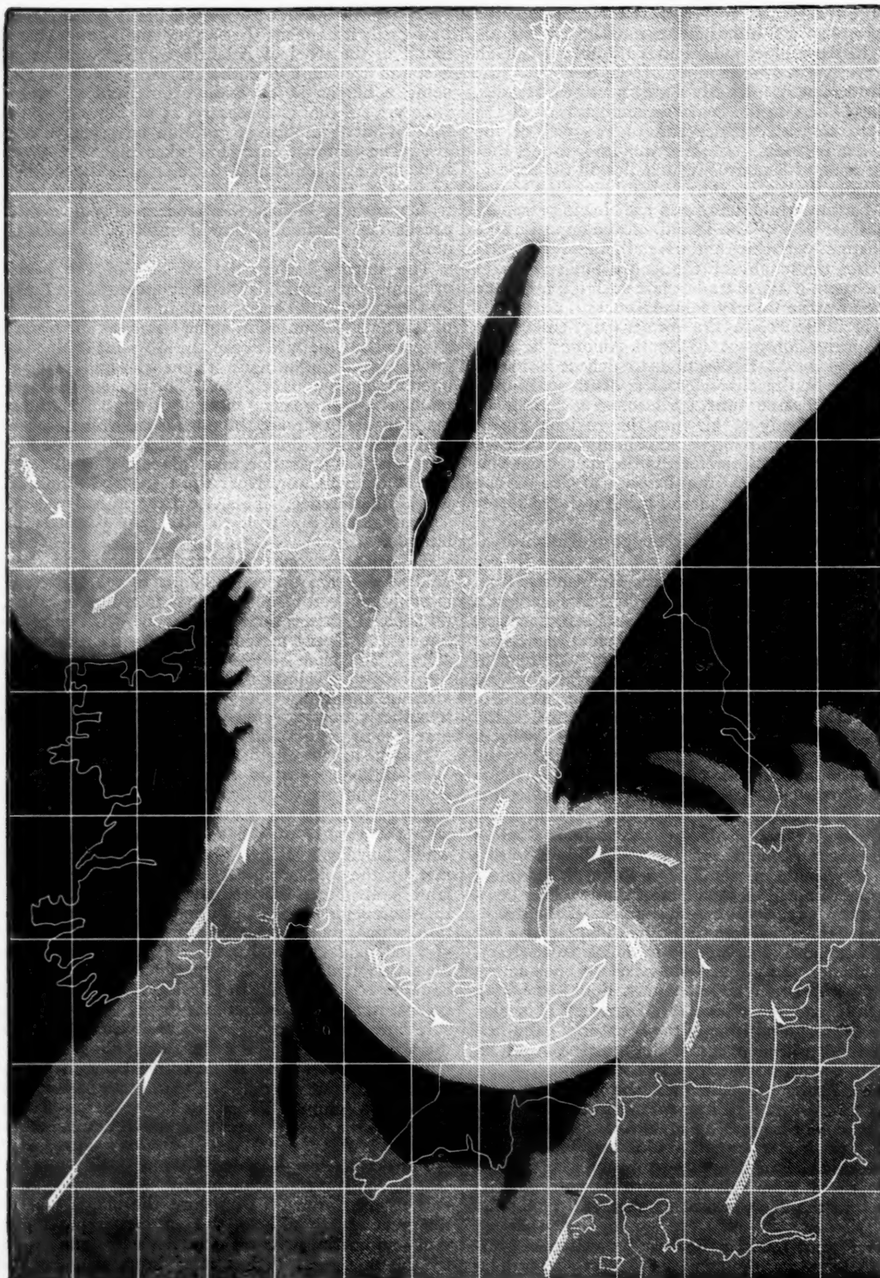
If it be asked along what parallels of latitude in our hemisphere this formation takes place, the intelligent reader will at once answer, Near the terrestrial circle of trade-wind interference. This, we have already seen, is in summer, from the 10th to the 12th parallels of north latitude.

This slender zone of debatable ground is the battle-field of the two opposing bands of the trades. There is really no need of observations to tell us as much. But millions of observations attest the fact. Every seaman knows it. Every meteorological writer tells the same story. You have only to examine physical charts from the time of Columbus and Magellan to this, to see the absolute unanimity of testimony, and to discover that the hypothesis now advanced, and the known facts of the case, are in perfect and minute accord.

If it be asked whether the origin and interest of the West-Indian gales is *solely* due to mechanical interference, the proper reply, it would appear, should be in the negative. As the south-east trade-wind comes laden with the vapour of the southern or water hemisphere, which Dové well called "the boiler" of the globe, it is met by the cold north-east trade from the northern, or land hemisphere. There must be a great difference in their temperatures, and consequently extensive condensation, which, by the reasoning of Mr. Clement Ley, would, of itself, explain the formation of the storm. That condensation greatly assists in producing or intensifying it, cannot be doubted. In the high latitudes, where the polar air-current is sometimes forced by barometric pressure into the southerly or equatorial current moving over the warm waters of the ocean, and thus heavily vapour-laden, the consequence is illustrated by such terrific and sudden tempests as that of the *Royal Charter*, distinctly proved by Admiral Fitzroy to have been generated between the opposite polar and equatorial currents off the coast of Wales.

But that the origin of great depression-systems is solely due to condensation can hardly be sustained, and seems entirely overthrown if we regard the single fact that, on the great equatorial belt—the belt of perennial precipitation—no hurricane or typhoon has ever been experienced by the mariner. It has long been, and is now, the almost universally accepted theory of meteorologists, that the reason no cyclones have ever been known to occur on the equator is, that there the earth's rotation exerts a deflecting influence on the winds, amounting to zero, and hence the formation of a whirl is impossible. This view is not satisfactory, because the nucleus of a depression

once formed on the equator, there would be intro-moving masses of air proportioned in violence to the amount of the depression and the steepness of the barometric gradient down which they rush to reach the point of



WEATHER-CHART OF GREAT BRITAIN, BEFORE "ROYAL CHARTER" STORM.
Full-feathered arrows show Polar current; half-feathered arrows show Equatorial current; dark-coloured surface not reported by vessels or land-observers.

lowest barometer. The true reason that no great cyclone has ever been formed nearer the equator than the third parallels of latitude appears to be, that the equatorial belt is a belt of *non-interference*.

*ON THE ORIGIN AND METAMORPHOSES OF INSECTS**

VII.

ON THE ORIGIN OF INSECTS

"PERSONNE," says Carl Vogt, "en Europe au moins, n'ose plus soutenir la Création indépendante et de toutes pièces des espèces," and though this statement is perhaps not strictly correct, still it is no doubt true, that the Doctrine of Evolution, in some form or

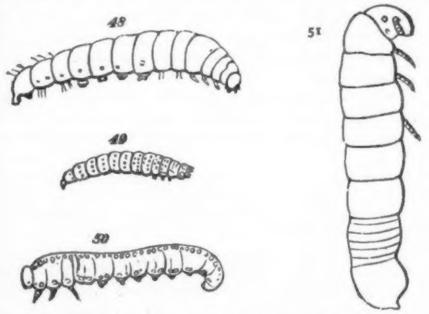


FIG. 48, Larva of Moth (*Agrotis suffusa*), after Packard. 49, Larva of Beetle (*Haltica*), after Westwood. 50, Larva of Sawfly (*Cimbex*), Brischke and Zaddach. Beob. ub d. artm. der Blall—Holzwespen, Fig. 8. 51, Larva of Julus. Newport, Philos. Transactions, 1841.

other, is accepted by most, if not by all, the greatest naturalists of Europe. Yet it is surprising how much, in spite of all that has been written, Mr. Darwin's views are

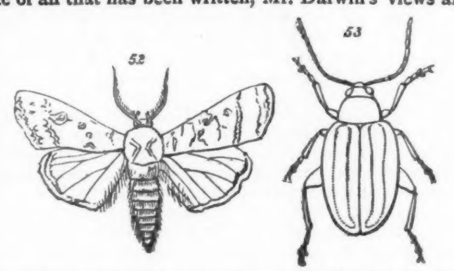


FIG. 52, Agrotis suffusa (after Packard). 53, Haltica (after Westwood).

still misunderstood. Thus Browning, in one of his recent poems, says:—

> "That mass man sprang from was a jelly lump
> Once on a time; he kept an after course
> Through fish and insect, reptile, bird, and beast,
> Till he attained to be an ape at last,
> Or last but one."†

FIG. 54, Cimbex, Brischke and Zaddach, l.c. T. 2, Fig. 9.

Yet this is a theory which Mr. Darwin would entirely repudiate; which is utterly inconsistent with his views. Whether fish and insect, reptile, bird, and beast, are derived from one original stock or not, they are certainly not links in one sequence. I do not, however, propose to discuss the question of Natural Selection, but I may observe that it is one thing to acknowledge that in Natural Selection, or the survival of the fittest, Mr. Darwin has called attention to a *vera causa*, has pointed

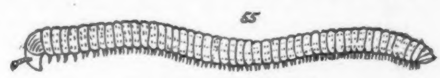


FIG. 55, Julus (after Gervais).

out the true explanation of certain phenomena; but it is quite another thing to maintain, that all animals are descended from one primordial source.

For my own part, I am satisfied that Natural Selection is a true cause, and that whatever may be the final result of our present inquiries—whether animated nature is derived from one ancestral source, or from many—the

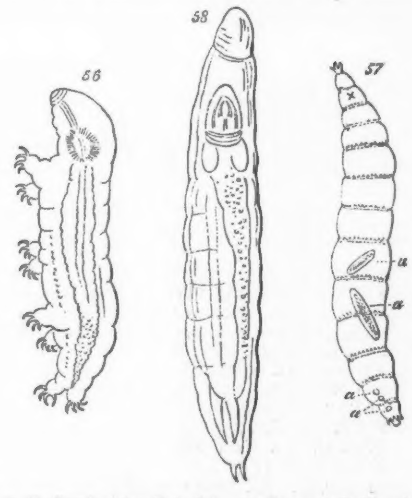


FIG. 56, Tardigrade (after Dujardin). 57, Larva of Cecidomyia (after Packard). 58, Lindia tomlosa (after Dujardin).

publication of the Origin of Species will not the less have constituted an epoch in the History of Biology. But, how far the present condition of living beings is due to that cause; how far, on the other hand, the action of Natural Selection has been modified and checked by other natural laws—by the unalterability of types, by atavism, &c.; how many types of life originally came into

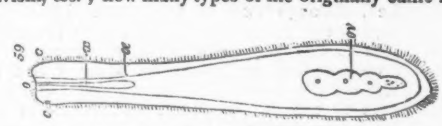


FIG. 59, Prorhynchus stagnalis.

being; and whether they arose simultaneously or successively,—these and many other similar questions remain unsolved, even if we admit the theory of Natural Selection. All this has indeed been clearly pointed out by Mr. Darwin himself, and would not need repetition but for the careless criticism by which in too many cases the true question has been obscured. Without, however, discussing the argument for and against Mr. Darwin's conclusions, we so often meet with travesties of it like that which I have just quoted, that it may be worth while to consider the stages through which some group, say for instance

* Continued from p. 140.
† Prince Hohenstiel Schwangau, p. 68.

that of insects, have probably come to be what they are, assuming them to have developed under natural laws from simpler organisms. The question is one of great difficulty. It is hardly necessary to say that insects cannot have passed through all the lower forms of animal life, and the true line of their development would not at present be agreed upon by all naturalists. In this question embryology and development are perhaps our best guides. The various groups of Crustacea, for instance, greatly as they differ in their mature condition, are for the most part very similar when they quit the egg. Haeckel, in his "Naturliche Schopfungsgeschichte," gives a diagram which illustrates this very clearly.

In the case of insects, the gradual course of evolution through which the present condition of the group has been probably arrived at, has been discussed by Mr. Darwin, by Fritz Müller, Haeckel, Brauer, myself and others. At first sight the differences are indeed great between the various groups of insects. The stag beetle, the dragon fly, the moth, the bee, the ant, the gnat, the grasshopper—these and other less familiar types seem at first to have little indeed in common. They differ in size,

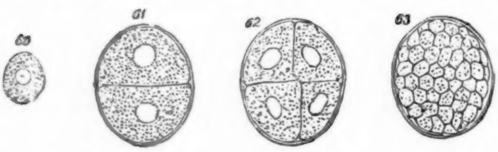


FIG. 60, Egg of Tardigrade, Kaufmann, Zeit. f. Wiss Zool. 1851, Pl. 1 61, Egg of Tardigrade after the yolk has subdivided. 62, Egg of Tardigrade in the next stage. 63, Egg of Tardigrade more advanced.

in form, in colour, in habits, and modes of life. Yet the researches of entomologists, following the clue supplied by the illustrious Savigny, have shown, not only that while differing greatly in details, they are constructed on one common plan; but also that other groups, as for instance, Crustacea (Lobsters, Crabs, &c.) and Arachnida (Spiders and Mites), can be shown to be fundamentally similar. In Pl. 4 I have figured the larvæ of an Ephemera (Fig. 1), of a Meloe (Fig. 2), of a Dragon Fly (Fig. 3), of a Sitaris (Fig. 4), of a Campodea (Fig. 5), of a Dyticus (Fig. 6), of a Termite (Fig. 7), of a Stylops (Fig. 8), and of a Thrips (Fig. 9). All these larvæ possess many characters in common. The mature forms are represented in the corresponding figures of Plate 3, and it will at once be seen how considerably they differ from one another. The same fact is also illustrated in Figs. 48—55, where Figs. 48—51 represent the larval states of the mature forms represented in Figs. 52—55. Fig. 48 is the larva of a moth, *Agrotis suffusa* (Fig. 52); Fig. 49 of a beetle, *Haltica* (Fig. 53); Fig. 50 of a Saw Fly, *Cimbex* (Fig. 54); and Fig. 51 of a Centipede, *Julus* (Fig. 55).

Thus then, although it can be demonstrated that perfect insects, however much they differ in appearance, are yet reducible to one type, the fact becomes much more evident if we compare the larvæ. M. Brauer* and I† have pointed out that two types of larvæ, which Packard has proposed to call the Eruciform and Leptiform, run through the principal groups of insects. This is obviously a fact of great importance: as all individual Meloës are derived from a form resembling Plate 2, Fig. 2, it is surely no rash hypothesis to suggest that the genus itself may be so.

Firstly, however, let me say a word as to the general Insect type. It may shortly be described as consisting of animals, possessing a head, with mouth-parts, eyes, and antennæ; a thorax made up of three segments, each with a pair of legs; and a many-segmented abdomen with anal appendages. Into the internal anatomy I will not now enter. It will be seen that Plate 4, Fig. 4, representing the larva of a small beetle named Sitaris, answers very well to this description. Many other Beetles are developed from larvæ closely resembling those of Meloë (Plate 4, Fig. 2), and Sitaris (Plate 4, Fig. 4); in fact—except those species the larvæ of which, as, for instance of the Weevils (Plate 2, Fig. 6), are internal feeders, and do not require legs—we may say that the Coleoptera generally are derived from larvæ of this type.

I will now pass to a second order, the Neuroptera. Plate 4, Fig. 1, represents the larva of Chloëon, a species the metamorphoses of which I described some years ago in the Linnean Transactions,* and it is obvious that in essential points it closely resembles the form which I have just described.

The Orthoptera, again, the order to which Grasshoppers, Crickets, Locusts, &c. belong, commence life in a similar condition, and the same may also be said of the Trichoptera.

From the difference in external form, and especially the large comparative size of the abdomen, the larvæ of Lepidoptera (Fig. 48), and of certain Hymenoptera, for instance, of Sirex (Fig. 14) and Tenthredo, the Saw Flies (Fig. 50), have generally been classed with the maggots of Flies, Bees, Weevils, &c., rather than with the more active form of larva just adverted to. This seems to me, as I have already pointed out,† to be a mistake. If we look, for instance, at the larva of Tenthredo we see the three thoracic segments well marked, and the three pairs of legs. The abdominal prolegs, indeed, give the larvæ a very different appearance to those of the preceding type, but in some respects remove them still further from the apod, vermiform, larvæ. The larvæ of other species belonging to this group, for instance of Lyda, have no abdominal prolegs, and well developed though short antennæ. The caterpillar type differs then in its general appearance owing to its greater clumsiness, but still essentially agrees with that already described.

No Dipterous larva, so far as I know, belongs truly to this type; in fact, the early stages of the pupa in the Diptera seem in some respects to correspond to the larvæ of other Insect orders. The Development of the Diptera is, however, as Weissman‡ has shown, very abnormal in other respects.

Thus then we find in many of the principal groups of insects that, greatly as they differ from one another in their mature condition, when they leave the egg they consist of a head; a three-segmented thorax, with three pairs of legs; and a many-jointed abdomen, often with anal appendages. Now is there any mature animal which answers to this description? We need not have been surprised if this type, through which it would appear that insects must have passed so many ages since (for winged Neuroptera have been found in the carboniferous strata) had long ago become extinct. Yet it is not so. The interesting genus Campodea (Pl. 3, Fig 5) still lives; it inhabits damp earth, and closely resembles the larva of Chloëon (Pl. 2, Fig. 1), constituting, indeed, a type which, as shown in Pl. 4, occurs in many orders of insects. It is true that the mouth parts of Campodea do not resemble either the strongly mandibulate form which prevails among the larvæ of Coleoptera, Orthoptera, Neuroptera, Hymenoptera, and Lepidoptera; or the suctorial type of the Homoptera and Heteroptera. It is, however, not the less interesting or significant on that account, since, as I have elsewhere endeavoured to point out, its mouth parts are intermediate§ between the mandibulate and haustillate types; a fact which seems to me highly significant.

It seems to me, then, that there are good grounds for

* Wien. Zool. Bot. Gessels, 1869.
† Linnean Transactions, 1863.

* Linnean Transactions, 1866, vol. xxv.
† Linnean Transactions, vol. xxiv. p 65.
‡ Siebold and Kolliker's Zeits. f. Wiss. Zool., 1864.
§ Linnæan Journal, v. xi.

considering that the various types of insects are descended from ancestors more or less resembling the genus Campodea, with a body divided into head, thorax, and abdomen; the head provided with mouth-parts, eyes, and one pair of antennæ, the thorax with three pairs of legs, and the abdomen, in all probability, with caudal appendages.

If these views are correct, the genus Campodea must be regarded as a form of remarkable interest, since it is the living representative of a primæval type from which not only the Collembola and Thysanura, but the other great orders of insects have derived their origin.

This ancient type may possibly have been derived from a less highly developed one, resembling the modern Tardigrades, a (Fig. 56) smaller and much less highly organised being than Campodea, which has been successively placed among the Acari and the Rotatora. It possesses two eyes, three anterior pairs of legs, and one at the posterior end of the body, giving it a curious resemblance to some Lepidopterous larvæ.

These legs, however, as it will be seen, are reduced to mere projections. But for them, the Tardigrada would closely resemble the vermiform larva so common among insects. Among the Coleoptera, for instance, the vermiform type occurs in the weevils; among Hymenoptera in the Bees and Ants; among Diptera it is general. Among Tricoptera the larva early acquires the three pairs of legs, but as Zaddach has shown,* there is a stage, though it is quickly passed through, in which the divisions of the body are indicated, but no trace of legs is yet present. Indeed, there appear to be reasons for considering that while among Crustacea the appendages appear before the segments, in Insects the segments precede the appendages, although this stage of development is very transitory, and apparently, in some cases, altogether suppressed. I say "apparently," because I am not yet satisfied that it will not eventually be found to occur in all cases. Zaddach, in his careful observations of the embryology of Phryganea, only once found a specimen in this stage, which also, according to the researches of Huxley,† seems to be little more than indicated in Aphis. It is therefore possible that in other cases, when no such stage has been observed, it is not really absent, but, from its transitoriness, has hitherto escaped attention.

Fritz Muller has expressed the opinion ‡ that this vermiform type is of comparatively recent origin; he says, "the ancient insects approached more nearly to the existing Orthoptera, and perhaps to the wingless Blattidæ, than to any other order, and the complete metamorphosis of the Beetles, Lepidotera, &c. is of later origin." "There were," he adds, "perfect insects before larvæ and pupæ." This opinion has been adopted by Mr. Packard § in his "Embryological Studies on Hexapodous Insects."

M. Brauer || also considers that the vermiform larva is a more recent type than the Hexapod form, and is to be regarded not as a developmental form, but as an adaptational modification of the earlier active hexapod type. In proof of this he quotes the case of Sitaris.

Considering, however, the peculiar habits of this genus, to which I have already referred, and that the vermiform type is altogether lower in organisation and less differentiated than the Campodea form, I cannot but regard this case as exceptional; as one in which the development has been, so to say, "falsified" by the struggle for existence, to use an expression of Fritz Müller's, and which therefore does not truly indicate the successive stages of evolution. On the contrary, the facts seem to me to point to the conclusion that, though the grublike larvæ of Coleoptera, and some other insects, owe their present form mainly to the influence of external circumstances, and partially also to atavism, still the Campodea type is itself derived from earlier vermiform ancestors. Nicolas Wagner has shown in the case of a small gnat, allied to Cecidomyia, that even now, in some instances, the vermiform larvæ retain the power of reproduction. Such a larva (as, for instance, Fig. 57) very closely resembles some of the Rotatoria, such, for instance, as Albertia or Notommata; these differ generally in possessing vibratile cilia. There is, however, one genus—Lindia (Fig. 58)—in which these ciliæ are altogether absent, and which, though resembling Macrobiotus in many respects, differs from that genus in being entirely destitute of legs. I have never met with it myself, but it is described by Dujardin, who found it in a ditch near Paris, as oblong, vermiform, divided into rings, and terminating posteriorly in two short conical appendages. The jaws are not unlike those of the larvæ of Flies, and indeed many naturalists meeting with such a creature would, I am sure, regard it as a small Dipterous larva; yet Dujardin figures a specimen containing an egg, and seems to have no doubt that it is a mature form.*

JOHN LUBBOCK

(To be continued.)

* Unters. ub. die Entwick. und der Bau der Gliederthiere, p. 73
† Linnean Transactions, v. xxii.
‡ Facts for Darwin, trans. by Dallas, p. 118.
§ Mem. Peabody Academy of Science, v. I. No. 3.
|| Wien. Zool. Bott. Gesells. 1869, p. 310.

* See also the descriptions given by Dujardin (Ann. des Sci. Nat. 1851, v. xv.) and Claparède (Anat. and Entwickl der Wirbellosen Thiere) of the interesting genus Echinoderes, which these two eminent naturalists unite in regarding as intermediate between the Annelides and the Crustacea.

AMERICAN SCIENTIFIC EXPEDITIONS †

THE present year will be pre-eminently characterised in the history of the United States by the number of scientific expeditions, thoroughly equipped in every respect, and fitted out for exploration in various regions of the great West; and although most of them have been already referred to in our columns, it may be well to recapitulate them in geographical order. The most northerly is the International Northern Boundary Commission, which is intended to survey the line of the forty-ninth parallel, from the Lake of the Woods to the crest of the Rocky Mountains. The survey of the eastern section of the northern boundary of the United States was completed many years ago by Colonel J. D. Graham and others, and that of the western section, from the Pacific coast to the Rocky Mountains, was brought to a close in 1860. The middle section, as was the western, is in charge of Archibald Campbell, Esq., of Washington, as commissioner, with Major Twining as chief engineer officer on the part of the United States. Dr. Elliott Coues, of the army, the well-known naturalist, accompanies the expedition in that capacity, and the work will be done in connection with a large party, equally well equipped, detailed by the British Government.

The labour of this Commission was begun in 1872, consisting in the examination of the line from the Lake of Woods to Pembina, this village being the starting-point for the present year.

The next expedition is that along the line of the Northern Pacific Railway, and will consist of a body of about 2,000 troops, under the immediate command of Colonel D. N. Stanley. This will concentrate at Fort Abraham Lincoln, on the Missouri, now representing the western terminus of the Northern Pacific Railway, and its route will be westward toward and across the Yellow Stone River. This large force is intended to keep the Indians in check, and prevent any interferences on their part with the location and construction parties of the railway. In view of the fact that this expedition passes through a rich but little-known country, abounding in objects of natural history and zoology, the president of the National Academy of Sciences memorialised the Secretary of War in reference to the appointment of a

† Communicated by the Scientific Editor of *Harper's Weekly*.

corps of scientific men to accompany it; and this communication being favourably received, a number of gentlemen were duly commissioned. Some of these, however, subsequently found themselves unable to carry out their intention; but finally an organisation was completed, with Mr. J. A. Allen, of Cambridge, as zoologist; Dr. Lionel R. Nettre, of New York, as mineralogist and geologist; Mr. William Pywell, of Washington, as photographer; Mr. Edward Konopicky, of Cambridge, as zoological and landscape artist; and Mr. C. W. Bennett as general assistant. These gentlemen have been commended especially to the kind attentions of General Sheridan and Colonel Stanley, and will receive every facility possible for carrying on their work.

The next expedition is that of Prof. F. V. Hayden, who continues the work upon which he has been engaged for so many years. His starting-point is Denver, and the region to be explored lies south of the fortieth parallel of latitude, and extending from Green River on the west to the eastern base of the Rocky Mountains. He expects to occupy several successive years in proceeding toward the Mexican boundary. The expedition has been divided into several parties, each with its commander. The general topographical and surveying work is under the direction of Mr. James T. Gardner, so well known in connection with Mr. Clarence King's explorations. Some of the specialists accompanying the expedition are Dr. F. M. Endlich and Mr. Marvin as geologists, and Mr. J. H. Batty as zoologist.

The next survey in the geographical order of arrangement is that of Lieutenant George M. Wheeler, in continuation of the labours of several preceding years. This expedition will be divided into four main field parties, one of which will be again subdivided, and includes four astronomical and triangulation parties. Party No. 1, under charge of Lieutenant Wheeler himself, will operate in portions of New Mexico and Arizona, and will be accompanied by Mr. G. K. Gilbert as chief geologist, and Dr. Oscar Loew as assistant geologist. Party No. 2, under Lieutenant Hoxie, will be accompanied by Mr. E. E. Howell as geologist, and Mr. H. W. Henshaw as naturalist. This party will move from Salt Lake to Camp Wingate, passing through portions of New Mexico and Arizona. The third party, under Lieutenant William L. Marshall, with Prof. J. J. Stevenson as geologist and mineralogist, and Dr. J. L. Rothrock as medical officer and naturalist, will move south-west from Denver through to Wingate, and explore also a portion of New Mexico and Arizona.

The fourth, or triangulation party, will start from Santa Fé, and carry a system of triangulation west to the meridian of Fort Wingate, and thence south to the Mexican border. The first astronomical party will be stationed at Salt Lake, with Mr. J. H. Clarke as observer; the second will be on the Denver and Santa Fé line, Dr. F. Kampf, observer; the third will be on the Union Pacific and the Central Pacific Railroad lines, with William W. Maryatt as observer; and the fourth party at Ogden, with Prof. H. B. Herr as observer. Here an observatory will be constructed for receiving signals from communicating stations, with a view of establishing differences of longitude.

The expedition of Major J. W. Powell on the Colorado River, in Utah, comes next in order, this gentleman being now occupied in finishing his work and preparing his report in compliance with the Act of Congress. Major Powell had been several years in this region, and has already constructed a map of wonderful interest and great accuracy. In connection with his work he has made a very large ethnological collection relating to the Piute Indians.

The explorations of Mr. Clarence King, who has been engaged for several years in the survey of the line of the fortieth parallel, will, it is understood, be completed during the present season by reviewing some portions of the route already traversed.

The engineer expedition under Captain Jones will also proceed from Cheyenne along the Wind River Mountains to some point on the Upper Missouri, and will be accompanied by Dr. Parry, the well-known botanist. It is also understood that a large Government party will start from Fort Ellis and proceed eastward, and form part of the Yellowstone expedition already referred to.

The exploration of Alaska will also be prosecuted in behalf of the Coast Survey by Mr. William H. Dall, who has already proceeded to the Aleutian Islands, with a view of preparing a proper chart of the same, and especially of selecting a suitable landing-place for the proposed Pacific Ocean cable. The labours of Mr. Henry W. Elliott and Captain Bryant in the islands of St. Paul and St. George, in Behring Sea, will, it is hoped, be as productive as in 1872.

Nearly all the parties referred to, while, of course, prepared for prosecuting the topographical, geographical, and astronomical service, are accompanied by competent geologists, botanists, and zoologists, and there is reason to believe that the amount of material which will be transmitted by them to the National Museum will exceed in magnitude and value that of any previous year since its establishment in 1857.

NOTES

AT a meeting of the Geographical Society on Monday evening, Sir Bartle Frere, who was in the chair, intimated that the Queen had been graciously pleased to grant a pension of 300*l.* a year to Dr. Livingstone. We are glad to see that the daily press is becoming alive to the scandal of putting off with such a paltry gift a man who has spent his life in the disinterested service of his country and of humanity: he has surely *earned* something more handsome. Sir Bartle Frere read a letter from Dr. Kirk, which stated that the East Coast Expedition was getting on well, and that its members were in good health. Dr. Dillon and Lieutenant Cameron had succeeded in traversing the wet country, and were now engaged in collecting porters on the inland side of the river. Lieutenant Murphy and Mr. Moffat were understood to be following. His arrival had done much for the assistance of the expedition. No further news had of late been received of the expedition, a circumstance regarded by Dr. Kirk in a favourable sense. A letter from Lieutenant Grandy, from the Western Expedition, was then read. In this communication the writer, in giving an account of the progress of the expedition, stated that the men were all well, and that the climate was deliciously cool.

THERE will be an Election to Five Scholarships at Jesus College, Oxford, on Tuesday, October 14. The annual value of the Scholarships is 80*l.*, and they are tenable to the close of the twentieth term from the Scholar's matriculation. Candidates must not on the day of election be full twenty-four years old. One of these Scholarships is an Open Scholarship. It will be given according to proficiency in Physical Science, combined with the Classical attainments required by the University. The Examination for this will commence on Tuesday, October 7, and it will be held at Magdalen College in company with that for a Magdalen Demyship and a Merton Post-Mastership. Papers will be set in Chemistry, Physics, and Biology; and an opportunity will be given of showing a knowledge of practical work in Chemistry and Biology. Candidates for this Scholarship, if not otherwise admitted to the Examination, are requested to call on the Principal of Jesus College, on Monday, Oct. 6; and if so admitted, to call upon him on any day in the same week, and to bring with them certificates of age and of past good conduct.

THERE will be an election to a Fellowship in Natural Science at Magdalen College, Oxford, in October next, the holder of which will not be required to take Holy Orders. The examination will be held in common with Merton College, preference being given to proficiency in Biology, the College reserving to themselves the power of taking candidates in any other branch of Natural Science if it shall seem expedient to do so. Candidates must have passed all the examinations required by the University of Oxford or University of Cambridge for the degree of Bachelor of Arts, and must not be in possession of any Ecclesiastical Benefice, or of any Property, Government Pension, or office tenable for life, or during good behaviour (not being an Academical office within the University of Oxford), the clear annual value of which shall exceed 230*l*. They must also produce testimonials of their fitness to become Fellows of the College as a place of religion, learning, and education, and these must be sent to the President on or before Monday, Sept. 29. Candidates are required to call on the President on Monday, Oct. 6, between the hours of 3 and 5, or 8 and 9 P.M. The examination will commence the following day.

DR. JAMES BOTTOMLEY, B.A., D.Sc., F.C.S., has been appointed to the Science Mastership of the Taunton College School. The liberality of two or three munificent friends has enabled the headmaster to place the science teaching on a new and enlarged footing. Science has been taught in the school since 1865 with imperfect instruments, accommodation, and teaching power, yet with sufficient thoroughness to pass many pupils in the London Matriculations and in the scientific portion of the Oxford Local Examinations. The apparatus will now be largely increased, a temporary but efficient laboratory is about to be erected, and a science master of the highest reputation has been secured.

THE fine specimen of the Octopus brought to the Brighton Aquarium from the French Coast in April last and suspected at the time by Mr. Saville Kent to be a female, has just verified this anticipation by depositing numerous eggs. The position selected by the creature for their lodgment is most opportune, the several clusters being attached to the rockwork, close to one another, within a few inches of the front glass of its tank; thus affording every facility for their observation to the general public, and enabling the officers on the Naturalist's Staff to watch their progress towards maturity from day to day. The eggs were deposited on Thursday last, the 19th inst., since which time the parent has vigilantly guarded them, usually encircling and partly concealing the whole within a coil of one or more of her snake-like arms, and vigorously repelling the near approach of any of her comrades in the same tank. Like those of the Argonaut or Paper Nautilus, the eggs of the Octopus are of small size compared with the ova of other Cephalopoda, the individuals being no more than one-eighth of an inch in length, of oval form, and are crowded round a central flexible stalk two or three inches long. A dozen or more of these compound clusters, each including over a hundred eggs, represent the number already deposited by the female Octopus in the Brighton tanks. The mate of the interesting parent is a fine fellow brought from the Cornish Coast last February. On the arrival of his fair companion he immediately vacated his oyster grotto in her favour and for many subsequent days lavished upon her the most assiduous attention.

MR. LIVINGSTONE STONE, the Assistant Commissioner on the part of the United States, has been engaged for some time past in collecting fresh-water fishes of various species to be transported to California, for the purpose of introducing them into the rivers and ponds of that State. For this purpose he had sent to him a car of the Central Pacific Railway, which he has had fitted up properly for this object. At one end of the car is a plank pond, lined with zinc and holding four tons of water, over which are berths for Mr. Stone and his assistants. The rest of the car is occupied with smaller tanks, and a reserve of sea and fresh water, household and commissary supplies, &c. Among the species that Mr. Stone carries with him, in the form of partly hatched eggs or young, are shad, cat-fish, yellow perch, wall-eyed or glass-eyed perch, eels, lobsters, and the like; and there is every reason to believe he will succeed in transferring his freight without material loss. If he accomplishes his object of placing these fish in the California waters, there is every reason to expect them to constitute before many years an important addition to the food resources of the State.

MR. BENTHAM'S Anniversary Address to the Linnean Society, just printed at the request of the Fellows, deals chiefly with the progress of physiological botany during the past year. He refers especially to Strasburger's investigations of the floral structure of Coniferæ and Gnetaceæ, and to the genealogical theory by which that botanist makes the Conifers the parent race from which the Gnetaceæ have directly descended, these again having engendered the higher Dicotyledons. This theory Mr. Bentham considers to rest on very slender grounds, preferring the hypothesis that the Gnetaceæ have remained the least modified from the common stock, the Coniferæ having undergone a greater progressive change in one direction, the total separation of the sexes, the Dicotyledons a greater advance in another direction, the increasing complexity of the floral development. Haeckel's conjectural pedigree of the Calcisponges is also criticised.

THE "session extraordinaire" of the Botanical Society of France will be held this year at Brussels under the auspices of the Royal Botanical Society of Belgium. The session will commence by a meeting at the Botanic Gardens, Brussels, on July 9, at 9 A.M. Excursions will be made to the botanical establishments at Brussels, Ghent, Liége, Antwerp, &c.; as well as to the grotto of Haux, the marshes of Hasselt, &c. English botanists are especially invited to take part in this meeting. The districts to be visited are stated to be of unusual interest from a botanical point of view.

THE subscriptions to the Sedgwick memorial give promise that a handsome museum will be erected to his memory. The amount already promised is very considerable. The Chancellor of the University, the Duke of Devonshire, heads the list with a donation of 1,000*l*. The High Steward, the Earl Powis, contributes 200*l*.; the Prince of Wales, 100 guineas; the Vice-Chancellor., Dr. Cookson, the two representatives in Parliament, the Right Hon. S. H. Walpole and Mr. Beresford Hope, as well as a large number of other gentlemen give 100*l*. each. The Earl of Derby has promised 200*l*., Prof. Selwyn, 500*l*.; the Master of Trinity College, 200*l*.; Prof. Lightfoot, 200*l*.

THE Royal Horticultural Society's Show at Bath was opened on Tuesday, and continues till Saturday.

THE official report of the Secretary of the U.S. Navy, respecting the Arctic exploring ship *Polaris*, dispels the suspicions respecting the manner of Captain Hall's death, and shows that the separation of the crew was accidental, but does not account for the failure of the *Polaris* to rescue the men on the ice. Important scientific results have been obtained. The supposed open Polar Sea proves to be a sound opening into Kennedy Channel, with an inlet on the east, probably marking the northern shore of Greenland. The *Tigress*, which has been purchased by the Navy department for the relief expedition, will start early in July.

THE Council appointed at the Conference of the Trades Guild of Learning, recently held at the Society of Arts, met on Saturday last. Amongst other business transacted it was resolved

that in addition to various other eminent men, the following, as representatives of literature, science, and art, be invited to become vice-presidents of the guild:—Prof. Huxley, Sir Francis Grant, Mr. Alfred Tennyson, Dr. W. B. Carpenter, Prof. Tyndall, Sir Antonio Brady, Lord Lyttelton, Mr. Thomas Hughes, M.P., Mr. J. A. Froude, and Sir Sterndale Bennett. It was further resolved that the annual subscription for ordinary members be one shilling or upwards, and for associate members one guinea or upwards; that application should be made for donations to meet the preliminary expenses, and to furnish an income until the society is self-supporting; and that a prospectus of the objects and plans of the society should be issued as soon as possible.

COMMODORE SELFRIDGE has returned to the Navy Department at Washington, bringing with him the materials for presenting a detailed report of his exploration upon the Isthmus of Darien during the past winter in reference to the construction of an inter-oceanic ship-canal. The result of his inquiries has been much more favourable than was anticipated, and it is now estimated that only twenty-eight miles of canal need be constructed, the remainder of the distance consisting of the perfectly navigable waters of the Atrato, Doguado, and Napipi rivers. A tunnel will still be necessary, as estimated on a previous exploration, but this will only require to be three miles in length, instead of five, and it is estimated that the entire distance can be completed at a cost of less than 70,000,000 dols. Twenty-two miles of the canal are over an almost level plain, and only nine locks in all will be needed.

WE have just received the first number of the Bulletin, or Proceedings of the Society of Natural History of Buffalo, New York. Four similar numbers are to be issued each year, with a few plates. The number before us is solely occupied by the work of Mr. Aug. R. Grote, who contributes four papers describing new North American Moths, and giving catalogues of the Sphingidae and Zygaemidae of North America, followed by conclusions drawn from a study of the genera Hypena, and Herminia.

SINCE the diffraction spectrum differs from a prismatic spectrum of the same length in having the less refrangible rays more widely dispersed, it some time ago suggested itself to Prof. C. A. Young that a so-called *gitter-platte* or "grating" of fine lines might advantageously replace the prisms in spectroscopes designed for the observation of the solar prominences through the C line. Having recently obtained one of the beautiful gratings ruled upon speculum metal, having a ruled surface of something more than a square inch, the lines being spaced at intervals of $\frac{1}{6480}$ of an inch, he combined this with the collimator and telescope of a common chemical spectroscope, thus getting an instrument furnishing a spectrum of the first order, in which the D lines are about twice as widely separated as by the flint glass prism of 60° belonging with the original instrument. In the neighbourhood of C the dispersion is nearly the same as would be given by four prisms. The spectra of the higher orders are generally not so well seen on account of their overlapping each other, but fortunately with one particular adjustment of the angle between the collimator and telescope, the C line in the spectrum of the third order can be made to fall in the vacant space between the spectra of the second and fourth orders. On applying the new instrument to the equatorial, Prof. Young found that in the first order spectrum he could easily see the bright chromosphere lines C, D_3, and F; he could also, though with great difficulty, make out $H\gamma$, (2796K). On opening the slit the outline of the chromosphere and the forms of the prominences were well seen, both in the spectra of the first and third order. The grating is much lighter and easier to manage than a train of prisms, and if similar ruled plates can be furnished by the opticians at reasonable prices and of satisfactory quality, it would seem that for observations upon the chromosphere and prominences they might well to some extent supersede prisms.

THE Eleventh Annual Report of the Free Libraries Committee of Birmingham is very carefully drawn up. It contains some valuable analytical tables showing the average numbers of those who daily take advantage of the library, the ages of the readers, their occupations, along with the number of volumes issued to readers of each occupation, and tables showing the books most in demand. From the latter item we are glad to see that science in its various departments comes in for a very fair share of attention. In April 1872 the Reference Library and the Art Gallery were thrown open to the public on Sunday afternoons, and to judge from the statistics, the privilege has been taken considerable advantage of, especially by those who have least time during the week for mental improvement.

IN the last number of the *Journal of the Statistical Society* is an interesting paper by Mr. F. Galton, F.R.S., on the Relative Supplies from Town and Country Families to the population of future generations. Mr. Galton took for the purpose of comparison, from the census returns, 1,000 families belonging to Coventry, in which there are various industries, and where the population is not increasing, and 1,000 families from small agricultural parishes in Warwickshire. After careful comparison and calculation, based on ascertained data, Mr. Galton concludes that the rate of supply in towns to the next adult generation is only 77 per cent., or, say, three-quarters of that in the country. In two generations the proportion falls to 59 per cent., that is, the adult grandchildren of artisan townsfolk are little more than half as numerous as those of labouring people who live in healthy country districts.

THE Reports and Proceedings for the year 1872–3 of the Miners' Association of Cornwall and Devon, contain some good papers, mostly of a practical nature, in connection with mining.

WE have received the Monthly Notices of the papers and proceedings of the Royal Society of Tasmania for 1870, 1871, and the half of 1872. A great part of them are occupied with valuable meteorological observations and statistics, and from the reports of the society's meetings and the numerous papers printed *in extenso* on subjects connected with all departments of science, we judge the society to be in a healthy condition. As might naturally be expected, many of the papers are devoted to the practical aspects of science, to pisciculture, arboriculture, agriculture, the rearing of sheep, &c.

WE would recommend to anyone visiting Derbyshire, especially the district around the Peak, Mr. Bates's little "Handbook to Castleton and its Neighbourhood," containing very full and well-compacted information on all the places of interest around. There is a useful section on the geology, mineralogy, and botany of the district, and we believe that Mr. John Tym, of Castleton, the publisher of the book, well known as a geologist, will willingly give anyone who calls at his shop, information on the natural history of the district.

WE would recommend to all Londoners who are at a loss how to spend an occasional holiday to procure the summer edition of Mr. Henry Walker's "Half-Holiday Guide," which is wonderfully cheap considering the quantity of matter it contains. It would take a few summers of half-holidays to exhaust all the charming resorts around London he describes. The book also contains much useful information for the botanist, geologist, ornithologist, entomologist, and microscopist, as well as with regard to various sports. Mr. Walker should, however, cease to quote so much irrelevant verse.

THE following additions have been made to the Brighton Aquarium during the past week:—Two Puffins (*Fratercula arctica*); small Crocodile (*Crocodilus sp.*) from Sumatra, presented by Captain Murray; Bass (*Labrax lupus*); Black Bream (*Cantharus lineatus*); Streaked Gurnards (*Trigla lineata*); Mackerel (*Scomber scomber*); Lumpfish (*Cyclopterus lumpus*); Grey Mullet (*Mugil capito*); Ballan Wrasse (*Labrus maculatus*); Flounders (*Pleuronectes flesus*), fresh-water variety, presented by F. J. Evans, Esq.; Herring (*Clupea harengus*); Conger Eels (*Conger vulgaris*); John Dorée (*Zeus faber*); Sea Horses (*Hippocampus ramulosus*) from the Mediterranean; Octopus (*Octopus vulgaris*); Oysters (*Ostrea edulis*); Zoophytes (*Actinoloba dianthus*), (*Sagartia nivea*), (*S. miniata*), (*Alcyonium digitatum*), (*Tubularia indivisa*).

THE additions to the Zoological Society's Gardens during the past week include a Dormouse Phalanger (*Dromicia nana*) from Tasmania, presented by Mast. W. F. Stratford; a Coati, brown variety (*Nasua nasica*) from S. America, presented by Mr. G. P. Crawford; a Lion (*Felis leo*) from Africa, presented by the Hon. M. E. G. Finch Hatton; a Rhesus Monkey (*Macacus erythreus*) from India, presented by Mr. J. C. Freeman; a Tasmanian Rat Kangaroo (*Hypsiprymnus cuniculus*), presented by Mr. J. Shelton; a Garnet's Galago (*Galago garnetti*) from E. Africa, presented by Mr. Bartle Frere; two horned Lizards (*Phryrosoma cornutum*) from Texas, presented by Mr. W. L. Booker; a Clifford's Snake (*Zamenis cliffordii*) from Cairo, presented by Mrs. E. Liveing; a black Stork (*Ciconia nigra*), two white Storks (*C. alba*), and a Spoon-bill (*Platalea leucorodia*), purchased; a red Kangaroo (*Macropus rufus*), and a Fallow Deer (*Dama vulgaris*), born in the Gardens.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 15.—"On the Heating of a Disc by Rapid Rotation *in vacuo*." By Prof. Balfour Stewart, M.A., F.R.S., and Prof. P. G. Tait, M.A.

In two previous communications to this Society, we gave an account of some experiments which we had made upon the heating of a disc through rotation *in vacuo*. In these experiments the increase of radiation of the heated disc was observed by means of a delicate thermopile and galvanometer. Three aluminium discs of various thicknesses and one ebonite disc were used, and the results derived from the experiments were as follows:—

(1) The heating effect observed appeared to be independent of the density, and of the chemical constitution of the residual air and vapour surrounding the discs.

(2) The quantity of heat developed under similar circumstances of rotation in three aluminium discs ·05, ·0375, ·025 of an inch in thickness respectively appeared to be the same, inasmuch as the relative thermometric effect for these discs varied inversely as their thickness.

(3) Besides the heating effect alluded to in (1) and (2), there was found to be, when the vacuum had been recently made, a strictly temporary effect, sometimes in the direction of heat, sometimes in that of cold, owing probably to the condensation or evaporation of small quantities of aqueous vapour; but this effect was only noticeable during rotation, disappearing the moment the motion was stopped.

In June 1871 the experiments were resumed. In the mean time the apparatus had been fitted with an arrangement working through a barometer-tube, by means of which, instead of trusting to radiation, the disc itself might, after rotation, be tapped by means of the pile, which could be brought up to it and then withdrawn. By this means a much larger effect might be obtained, and it became possible, by varying the adjustment, to find according to what law the heat-effect varies with the distance from the centre.

These experiments were conducted in the following manner: The disc was first of all tapped before rotation several times; at each tapping the momentary swing of the needle was recorded, and the mean of the readings was regarded as indicating the state of the disc with respect to heat.

The disc was next tapped after rotation, and the difference between the readings before and after was taken as indicating the change in the state of the disc produced by rotation.

The results derived by tapping an ebonite disc were found to be very different from the radiation-results, inasmuch as in the former the effect of the pressure and quality of the residual air is very apparent, while in the radiation-results it is hardly perceptible. A probable explanation of this will be given afterwards, but in the mean time, in view of these results, it has been thought expedient to discuss them quite independently and by themselves, with the view of ascertaining whether they can best be explained by a gas-effect alone, or whether they likewise indicate a residual effect independent of gas.

With this object calling A B the results at $\frac{9}{20}$ and $\frac{3}{20}$ let us take $\frac{(A)+(B)}{2}$ as representing the *whole effect* at a pressure of $\frac{6}{20}$ in. due to whatever cause or causes. We thus obtain

	Dry hydrogen.	Dry air.	Dry carbonic acid.
Whole effect at $\frac{6}{20}$ . .	9·5	25·0	24·0

Again, let us suppose that (A) − (B) denotes the *gas effect* for $\frac{6}{20}$ in., and we obtain

	Dry hydrogen.	Dry air.	Dry carbonic acid.
Gas-effect at $\frac{6}{20}$ . . .	4·0	20·0	18·0

Finally, let us regard as *unknown residual effect* the difference between the *whole effect* and the *gas-effect*, and we obtain

	Dry hydrogen.	Dry air.	Dry carbonic acid
Residual effect . . .	5·5	5·0	6·0

Similar experiments with the same galvanometer were made with a disc of cartridge-paper, of which the pores were filled with solid paraffin.

Treating these results in the same manner as those of the ebonite disc, we obtain:—

	Dry hydrogen.	Dry air.	Dry carbonic acid.
Whole effect ($\frac{6}{20}$) . .	25·0	45·0	43·5
Gas-effect ($\frac{6}{20}$) . . .	4·0	20·0	23·0
Residual effect . . .	21·0	25·0	20·5

Now, if we suppose that there is only one effect due to gas, it follows:—

(α) That the proportion between the effects due to the various gases experimented on (and all of the same pressure) is nevertheless different for the two discs.

(β) That the proportion (for the same disc) between the effects due to the various gases experimented on is different according to the pressure.

If, however, we suppose that there are two effects, one of which is independent of the residual gas, we find:—

(α) That, as regards the *gas-effect*, the proportion between that due to the various gases is nearly the same for both discs. Thus in the ebonite disc we have 4, 20, 18, while in the paper disc we have 4, 20, 23 as representing the gas-effect for the various gases.

(β) That the *residual effect* in either disc is nearly the same for the various gases. Thus in the ebonite disc we have 5·5, 5·0, 6·0, while in the paper disc we have 21·0, 25·0, 20·5 as representing the residual effect for the various gases.

The results are thus much more simple on the hypothesis of two effects, one of these being independent of the residual gas, than on the hypothesis of only one effect.

It was next endeavoured to ascertain whether these two effects were differently influenced by a blind, and it was found that the proportion between the two effects is greatly altered by the blind, so that while the hydrogen effect is not much stopped, the other is diminished very considerably; it was therefore concluded that the residual effect is not much altered by a chamois leather blind.

It was suggested to us by Prof. Helmholtz that it would be desirable to ascertain whether any difference was produced in the results by loading the disc on one side; for if these results be due to vibration, it might be supposed that they would be affected by this means.

It has been seen that the residual effect obtained from a disc covered with chamois leather is approximately the same as that from an uncovered disc; this would appear to us to be against the vibration hypothesis.

In an experiment made the disc was covered with a chamois leather blind with a segment cut out.

From a mean of two sets of experiments we may conclude that this arrangement does not much influence the results.

The disc was next treated in the following manner :—

It was covered with a chamois leather blind tied into holes drilled in the disc, and having two pieces of different shape cut out. The experiments gave (for an atmosphere of $\frac{3}{20}$ dry hydrogen) tapping in A 54, tapping in B 56, while for an uncovered disc they gave 53 as the heat-result. All these experiments apparently combine to prove that the result is not due to vibration.

Our next experiments were made with the view of testing whether or not the two effects, the residual and the gas-effect, were resident in the same particles of the disc ; and for this purpose the experiments made immediately after rotation were compared with those made one minute afterwards.

The experiments available for this purpose are so numerous that they can bear splitting into two portions, in each of which the same result is seen.

Thus we have for an atmosphere of $\frac{3}{20}$ dry hydrogen, and as the mean of 30 individual comparisons.

Effect at first : Effect one minute after : : 1·30 : 1 ;

also, as the mean of 22 individual comparisons, we obtain the proportion of 1·19 : 1, while as the mean of the whole we obtain 1·25 : 1.

Treating in a similar manner the observations made with an atmosphere of $\frac{3}{20}$ hyd. + $\frac{6}{20}$ air, we obtain

As the mean of 25 comparisons .... 1·47 : 1.
As the mean of 21 comparisons .... 1·41 : 1,

while as the mean of the whole we obtain 1·44 : 1.

We therefore conclude that the residual effect is less diminished during the interval of one minute than the gas-effect.

We next made experiments with two aluminium discs ·05 and ·025 of an inch in thickness respectively. These discs were covered on both sides with a coating of lampblack applied by negative photographic varnish.

From these experiments it was concluded that there are two effects which are differently distributed over the particles of the disc

It also appeared that the effect for $\frac{3}{20}$ hyd. which may be supposed to represent the residual effect, and that for $\frac{3}{20}$ hyd. + $\frac{6}{20}$ air, which may be supposed to represent the gas-effect, are both diminished in very nearly the same proportion, namely 100 : 77, by a transference of the pile to a position nearer the centre of the disc. And it was furthermore concluded from the experiments that in an aluminium disc covered with varnish, as well as in a disc of ebonite, we may imagine the residual effect to be more deeply seated than the gas-effect.

We venture on the following as what appears to us to be the most probable explanation of the whole body of experiments, including those with radiation.

(1) There is a temporary heat or cold effect which may be supposed to arise in particles very slightly attached to the disc ; this is radiated off chiefly during rotation, and does not probably greatly affect the disc afterwards.

(2) There is a surface gas-effect, which in an aluminium and even in an ebonite disc is conducted into the interior as it arises, so that it does not greatly radiate during rotation of the disc. In a paper disc, however, which is formed of a badly conducting material loosely put together, part of the effect does escape as radiation during rotation.

(3) There is a residual effect, which is more deeply seated than the gas-effect. And inasmuch as radiation takes place from a perceptible depth, this effect is much more influential than the gas-effect in increasing radiation after rotation. In the case of a paper disc, this deeply seated effect will be less diminished by radiation during rotation than the gas-effect, and therefore after rotation in such a disc we might expect the gas-effect to be peculiarly small.

In the course of these experiments we have endeavoured to prove that this residual effect is not caused by vibration. The radiation-experiments with aluminium discs of three different thicknesses went, on the other hand, to show that it was of the nature of a surface-effect. This is confirmed by the results derived from tapping ; for, in the first place, the experiments with aluminium discs show that the two effects (the residual and the gas-effect) are probably distributed in the same proportion, going from the centre to the circumference of the disc. Again, taking the two discs of thickness ·05 and ·025 of an inch, we obtain the following results :—

	Effect for $\frac{3}{20}$ hyd.	Effect for $\frac{3}{20}$ hyd. + $\frac{6}{20}$ air.
Thin disc ...	48 (22 observations).	228 (10 observations).
Thick disc...	29 (20 observations).	103 (10 observations).

Now, allowing for errors of experiment, we see that the residual, as well as the gas-effect, is reduced to about one-half for the thick disc.

Again, an experiment of a similar nature gave the effect for $\frac{3}{20}$ hyd. in an ebonite disc of $\frac{1}{10}$ in. in thickness = 33 against a result = 55 for the thin ebonite disc. Unfortunately it was omitted to make a comparison with these two discs for the gas-effect ; nevertheless these results are all in favour of the residual effect being a surface-effect.

Our conclusion from the evidence before us is, that the residual effect is a surface-effect more deeply seated than the gas-effect, but distributed outwards from the centre to the circumference, very much in the same manner as the gas-effect. The residual effect likewise appears able to penetrate a chamois leather blind without any perceptible diminution. We regard these conclusions as preliminary, and shall endeavour in our future experiments to procure additional evidence of these properties of the residual effect, as well as to obtain new facts regarding it In the meantime, as the subject is one of interest, and has been already too long delayed, we have not hesitated to bring these results before the notice of the Royal Society

Geological Society, June 11.—Prof. Ramsay, F.R.S., vice-president, in the chair.—The following communications were read :—"On the nature and probable origin of the superficial deposits in the valleys and deserts of Central Persia," by W. T. Blanford. The general results may be summed up as follows :—Persia has undergone a gradual change from a moister to a drier climate simultaneously with the elevation of portions of its surface, resulting first in the conversion of old river-valleys into enclosed basins containing large lakes, probably brackish or salt. Then, as the rainfall diminished, the lakes gradually dried up, leaving desert plains. The amount of subaërial disintegration among the rocks of the high ground he considered to be in excess of the force available for its removal, the water which now falls only sufficing to wash the loosened materials from the steeper slopes into the valleys, and hence the valleys in the upper parts are gradually being filled up with coarse gravel-like detritus, just as their lower portions have been already hidden beneath lake-deposits —"On *Caryophyllia Bredai* (Milne-Edwards and Haime) from the Red Crag of Woodbridge." by Prof. P. Martin Duncan, F.R.S. The author recorded the occurrence in the Red Crag of the Woodbridge district of a variety of *Caryophyllia Bredai* (Milne-Edwards and Haime).—"On the Cephalopoda-bed and the Ooolite Sands of Dorset and part of Somerset," by James Buckman, F.L.S. From an investigation of the Cephalopoda-bed in quarries at Bradford Abbas in Dorsetshire, the author comes to the conclusion that it is quite distinct from the Cephalopoda-bed of Gloucestershire, and that it is the representative of the Rubbly Oolite at the top of Leckhampton Hill and Cold Comfort, and of the Gryphite and *Trigonia*-beds of the neighbourhood of Cheltenham. The Gloucestershire Cephalopoda-bed he regards as situated close to the bottom of the Interior Oolite series ; and this is also the position to which he refers the sandy beds above mentioned.—"*Cetarthrosaurus Walkeri* (Seeley), an Ichthyosaurian from the Cambridge Upper Greensand," by H. G. Seeley, F.L.S. In this paper the author described a small Ichthyosaurian femur, discovered by Mr. J. F. Walker in the Upper Greensand of Cambridge. He noticed the general characteristics of the femur in Ichthyosaurians, and pointed out, as the chief peculiarities of the bone that he was describing, the subovate form of its head, and the presence of large flattened lateral trochanters, which, if of equal dimensions on both sides of the bone, would have made its greatest transverse measurement greater than its length. Upon this bone he proposed to found new a genus, *Cetarthrosaurus*.

Royal Astronomical Society, June 13.—Prof. Cayley, F.R.S., president, in the chair.—S. J. Lambert, of Newton Observatory, Auckland, was elected a Fellow of the Society.—The Rev. J. Vale Mummery presented a large photographic portrait of Mrs. Somerville. He said that the Society had long been possessed of a portrait of Miss Caroline Herschel, and he was glad now to be the means of finding her so fitting a companion. Mrs. Somerville and Miss Herschel had been admitted as honorary members of the Society on the same evening in 1834. They had long been separated, first by distance and then

by death, and it was only fitting that their portraits should now be hung together on the walls of the Society.—Paper "On a stereographic projection of the transit of Venus in 1882," by R. A. Proctor. The author said that his paper was intended to show the desirableness of limiting the preparations for Halley's method to the transit of 1874. In the transit of 1882 the lines bounding the region where the whole transit can be seen will lie much closer. This is the natural effect of the transit lasting only six hours. Again, the southern pole where difference of duration is greatest, instead of lying within the region where the whole transit can be seen as in 1874, lies outside that region. It should be remembered also that in searching for suitable places of observation a fringe of 10° wide, measuring along the lines where the beginning and end of the transit are seen at sunrise or sunset, must be thrown out of account. Taking this into account the transit of 1882 is seen to be very little suited for Halley's method. Maps were shown to illustrate the paper.—"On occultations of stars by the moon and eclipses of Jupiter's satellites," by the Rev. R. Main. This paper contained a very extensive table of observations of eclipses of Jupiter's satellites. Several such sets of observations have recently been received by the Society, and it was remarked that a paper on the subject read by the Astronomer Royal last year was beginning to bear good fruit.—"Note on the discovery of a new minor planet, No. 131," by Dr. Peters. This is the nineteenth planet discovered by Dr. Peters. Dr. Luther has also discovered 19. Thanks to the American telegraphic system, it has already been observed in England as well as at Leipzig and Marseilles.—"Note on the Mass of Jupiter," by W. T. Lynn. In 1866, he had had the honour of laying before the Society an account of a determination of this element by Prof. Krüger, of Helsingfors. That determination having been recently improved by the aid of subsequent observations, the result was communicated by the author to the *Astronomische Nachrichten* (No. 1,941.) Mr. Syme has, in this "Note," placed it in juxtaposition with the determinations by Airy, Bessel, Jacobs, and Möller. The agreement thus shown is very satisfactory, especially as the methods employed are different—Airy, Bessel, and Jacobs deducing Jupiter's mass from the motions of his satellites, Möller from those of Faye's Comet, and Krügen from those of the planet Kemis. This important element in the solar system may be considered as well established.—"Note on Dr. Oudeman's Photographs of the Solar Eclipse of Dec. 11, 1871," by Col. Tennant. He had received two paper copies of the photographs taken in Java. He could recognise almost every depression of outline as in the Indian photographs, but there was much less detail. He thought we might learn something from them as to photography. It was evident that the light was more intense than in the Indian photographs, but the exposure for a short time had not had the effect of producing the halation which was there visible. He was convinced that in future eclipses it will be better to use a reflector. —Mr. Ranyard remarked that the paper copies of the Dutch photographs which he had seen had been printed from enlargements on glass in which the moon had been stopped out with black paper, or some other material. On measuring, he had found that the body of the moon, as given in the photographs, was by no means circular; and Mr. Davis had pointed out to him that the irradiation under the prominences was perfectly sharp at the edges as it would be when printed through a paper nitch. It was therefore unfair to institute any comparisons as to the amount of the irradiation in these and in the other photographs. —"Note on the sympathetic influence of clocks," by Mr. William Ellis. He had been testing a number of clocks placed upon a wooden frame at the Royal Observatory. At first he found a sympathetic influence, but when the frame was considerably strengthened, so as to prevent vibration, they ceased to influence one another. He concluded that the popular notion as to the vibrations in the air produced by the swing of one pendulum having any susceptible influence on another swinging near to it was erroneous.—"On a recording micrometer," by Mr. W. H. Christie. This contained a description of two rather elaborate instruments for recording the transits of stars by pricks on a long strip of paper. It is intended to make experiments as to the possible use of the instruments at Greenwich.—Proposal to determine the solar parallax by observations of the opposition of the planet Flora. M. Galle invited the assistance of English and Australian astronomers. He had prepared and submitted to the Society a long list of suitable comparison stars.

Linnean Society, June 19.—Mr. Bentham, president, in the chair.—Prof. P. M. Duncan read a paper on the Development of the Gynæcium and method of Fertilisation of the Ovule in *Primula vulgaris*. Prof. Duncan had carefully followed the account given by Duchartre of the mode of development of the ovule in Primulaceæ, from which he differed in many important points, believing that the French observer had been led into error by dissecting only a cultivated and therefore to some extent abnormal variety. In tracing the development of the floral organs Duchartre states that he first of all detected the calyx, then the stamens, and finally the pistil, the placenta being formed in the centre of the cavity of the pistil, and never connected with the ovarian wall. With this statement Payen agrees. Dr. Duncan's observations agreed with these as far as the formation of the calyx and stamens was concerned; but within the latter he found simply a mamillary process. At the next stage there was a very short style, solid and not perforated, the ovarian wall including the placenta on which were the rudimentary ovules; the ovarian wall does not grow up over the placenta, but is produced from it by a kind of differentiation; subsequently the style lengthens and the small stigma is produced. The ovules appear in a spiral series, and are recognised by their power of reflecting light; the summit of the placenta has never any connection with the style. The ovule consists of nothing but a single integument and an embryo-sac: there is no inner integument and no nucleus. The lower portion of the tissue of the style is absolutely impervious to the pollen-tubes; and if these could enter the ovary in this way, the micropyles are in such intimate contact with the placenta, that they could never be reached by the tubes from the cavity of the ovary. Dr. Duncan has detected the passage of the pollen-tubes actually through the tissue of the placenta itself, from which they again emerge to reach the micropyle of the ovule. In the discussion which followed, this view of the course of the pollen-tubes was confirmed by Dr. T. S. Cobbold.—Dr Hooker read a paper by the Rev. C. New, on the sub-alpine vegetation of Kilma njaro. This is the only tropical African alpine flora with which we are acquainted; the mountain being situated in Eastern Africa, 3° S. lat, rising to a height of 20,000 ft., or nearly 5,000 ft. above the snow-level. The flora is essentially that of the Cameroons. The flora may be divided into seven regions of successive heights; the 1st is the inhabited district, with plantains, maize, &c.; the 2nd region is jungle; the 3rd is a forest of gigantic trees covered with moss, the herbaceous vegetation being essentially European, with the dock and stinging-nettle, frosts almost every night; the 4th consists of green hills covered with clover; the 5th is heath; the 6th bare hills; the 7th, everlasting snow. Of the fifty species contained in the collection, twenty were from the zone immediately beneath the perpetual snow; nearly all were of South African genera, very few European, and no new species not already known from the Cameroons. The flora is therefore essentially South African.

Meteorological Society, June 18.—Dr. J. W. Tripe, president, in the chair.—The following papers were read:—On some results of temperature observations at Durham, by John J. Plummer.—On the Meteorology of New Zealand, 1872, by C. R. Marten.—On the Climate of Vancouver Island, by Robert H. Scott, F.R.S.—Meteorological Observations at Zi-Ka Wei, near Shanghai, by Rev. A. M. Colombel, with note by Rev. S. J. Perry, F.R.A.S.—Notes on the connection between Colliery Explosions and Weather, by R. H. Scott, F.R.S., and William Galloway.—Distribution of Rainfall Maxima in Great Britain and Ireland between the years 1848 and 1872 inclusive, by W. R. Birt, F.R.A.S., and note on the heavy Rainfall of March 4 at Natal, by R. J. Mann, M.D., F.R.A.S. The ordinary meeting was then adjourned and the Annual General Meeting was held, and the Report of the Council read. The Report stated that the Council had much pleasure in congratulating the Society, at the close of the twenty-third session, upon the termination of a year which will bear favourable comparison with any that precedes it, whether regard be had to the character of the papers read, to the attendance at the periodic meetings, to the number of new Fellows elected, or to the activity and interest evinced in the general proceedings. It was stated that it had been found necessary to hold an extra meeting in May to enable all the papers which had been received to be presented before the Society; and the Council had the gratification to announce that it is in contemplation to hold eight monthly meetings next session, instead of six as has been the practice hitherto. The number of new Fellows added to the Society during the year had amounted to 35, the accession thus indicated being considerably larger than upon any years since 1864. Reference

was made to the library, the financial affairs, the proposed alterations of the bye-laws, and the recent meteorological conference at Leipzig; and the Council concluded by stating that they had had under consideration that evening a letter from the Board of Trade with reference to sending a representative to the Meteorological Congress to be held at Vienna in September next. The President then delivered an Address in which he chiefly referred to the progress of the Society during the two years that he had occupied the presidential chair. The following gentlemen were elected officers and council for the ensuing year:—President—Dr. Robert James Mann, F.R.A.S. Vice-presidents—Arthur Brewin, F.R.A.S., George Dines, Henry Storks Eaton, Lieut.-Col. Alexander Strange, F.R.S. Treasurer—Henry Perigal, F.R.A.S. Trustees—Sir Antonio Brady, F.G.S., Stephen William Silver, F.R.G.S. Secretaries—George James Symons, John W. Tripe, M.D. Foreign Secretary—Robert H. Scott, F.R.S. Council—Charles Brooke, F.R.S., Charles O. F. Cator, Rogers Field, C.E., Frederic Gaster, James Glaisher, F.R.S., John Knox Laughton, F.R.A.S., William Carpenter Nash, Thomas Sopwith, F.R.S., Rev. Fenwick W. Stow, M.A., Capt. Henry Toynbee, F.R.A.S., Charles Vincent Walker, F.R.S., E. O. Wildman Whitehouse, C.E.

BERLIN

German Chemical Society, June 9.—A. W. Hofmann, president, in the chair. A. Behr and Van Dorp report oxide of lead heated in iron tubes to be a good oxidising agent for organic vapours: $C_6H_4(CH_3)_2$ yielding $C_6H_4(CH)_2$, &c.—E. Salkowsky has found that taurine escapes digestion in the human body to a large extent. A small quantity of the following compound, however, passes into the urine; a crystallised acid of the empirical formula, $C_3H_8N_2SO_4$, forming quadratic plates, which are easily soluble, and giving well-crystallised salts with Ba, Ag, &c. With baryta water it yields taurine, carbonic acid and ammonia. The acid appears to be a substitution product of our hydrogen in taurine through carbaminic acid. Dr. Salkowsky took 5 grammes of taurine for twelve days following without suffering any great inconvenience to his health.—T. Thomsen sent in the results of very numerous experiments on the heat absorbed or developed by dissolving various salts in water. The same *savant* attacks the calorimetric method employed by Berthelot, and disputes his conclusions as to the existence of a hydrate $HCl + 8H_2O$.—K. Heumann has found that copper in contact with sulfide of ammonium becomes covered with crystals of subsulfide Cu_2S, according to the reaction $2CuO + 2(NH_4)_2S = Cu_2S + 4NH_3 + 2H_2O + S$.—H. v. Gegenfeld reports on the action of hypochlorous acid HClO on allylic chloride. The dichlorhydrine thus formed he considers as isomeric with that prepared from glycerine, while L. Henry obtained a body through the same reaction, which he considers as identical with ordinary dichlorhydrine.—L. Bisschopinck has studied the amides and the nitrites of the three chloracetic acids, particularly with regard to their physical properties. The most prominent result is the following irregularity in the boiling points of the nitriles, namely:—

$CH_3 . CN$	boils at	81—82°
$CH_2Cl . CN$	,,	123—124°
$CHCl_2 . CN$	,,	113—113°
$CCl_3 . CN$	,,	83—84°

The foregoing remarks were accompanied by a note of M. L. Henry on the boiling-points of the cyanides of negative radicals. He points out that if in HCN, H is replaced by a negative element or radical, the boiling point sinks; thus HCN 26°, Cl . CN 15°, CN . CN —21°, adding other examples, and the attempt of an explanation of this exceptional phenomenon. The same chemist has continued his researches on propargylic alcohol C_3H_3OH. He has found its boiling point equal to 114°, and he has prepared the bromide, the iodide, the sulfocyanide, and the acetate belonging to it. In treating brominated allylic alcohol $C_3H_4Br . OH$ with potash, he obtains besides propargylic alcohol an ether $(C_3H_4Br)_2O$, and perhaps also propargylic ether, which has not as yet been obtained in the pure state.

PARIS

Academy of Sciences, June 16.—M. de Quatrefages, president, in the chair. The following papers were read:—On the combustion heat of formic acid, by M. Berthelot.—On the alloys used for gold coinage, by M. Eug. Pelegot. The author advocated the addition of zinc to the alloy, and at the same time the reduction of the gold to a very great amount. He mentions with favour alloys containing from 48 to 66 mill. zinc, 354 to 372 copper, and 580 to 581 gold.—A report on the papers on *Phylloxera*, by MM. Duclaux, Max. Cornu, and L. Faucon was presented.—On the complete movements of a ship oscillating in calm water, by MM. O. Duhil, de Benazé and P. Risbec. The authors gave an account of their experiments on the *Elorn*, a vessel of 100 tons displacement.—Photo-chemical researches on the use of gases as developers, and on the influence of physical conditions as regards sensitisation, by M. Merget, was a paper on some of the chemical phenomena of photography.—On a scientific balloon ascent on the 26th April, 1873, by MM. Crocé-Spinelli, Jobert, Pénaud, Petard, and Sivel.—Announcement of the discovery of Planet 132 at Washington on the 14th June, by Prof. Henry.—Researches on electricity produced by mechanical actions, &c., by M. L. Joulin. Researches on essence of alan-gilan (*Unona odoratissima*), by M. H. Gal. The author has discovered benzoic acid in this essence, and believes that this is the first instance of this body being found in an essence, it having hitherto been found only in the balsams.—Contributions to the history of the histologic constitution of Molitg's glarin, by M. A. Bechamp. This paper related to the gelatinous body found in the sulphurous springs of the Pyrenees. The author finds that microscopic examination shows it to be a mass of microzymes imprisoned in a hyalin matrix. He has tried various experiments on its action as a ferment.—On the estimation of the total nitrogen in manures, by M. H. Pellet.—On the estimation of phosphoric acid in natural phosphates, super-phosphates, and manures, by M. H. Joulie.—On a process for the estimation of hæmoglobin in blood, by M. Quinquaud.—On the determination of the mechanical equivalent of food, by M. A. Sanson. The author pointed out the immense value to all employers of animal motive power, such as military authorities, &c., of the value of a method for ascertaining the value in work of the forage they use for their horses. He estimated the value of 1 kilo. of protein in a good average ration, as, in round numbers, 1,600,000 metre-kilograms.—Experimental researches on the influence of barometric changes on the phenomena of life, 11th note, by M. P. Bert.

DIARY

THURSDAY, JUNE 26.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JUNE 27.

QUEKETT CLUB, at 8.

SATURDAY, JUNE 28.

GEOLOGISTS' ASSOCIATION.—Excursion to Hatfield.

TUESDAY, JULY 1.

SOCIETY OF BIBLICAL ARCHÆOLOGY, at 8.30.—The Fall of Nineveh and the First Year of Nebuchadnezzar, King of Babylon: J. W. Bosanquet.

WEDNESDAY, JULY 2.

HORTICULTURAL SOCIETY.—Rose Show.

BOOKS RECEIVED

ENGLISH.—Field Pocket Book for the Auxiliary Forces: Colonel Sir Garnett Wolseley (Macmillan and Co.).—Education of Man (Charles Griffin & Co.)—Light Science for Leisure Hours. 2nd Series: R. A. Proctor (Longmans & Co.).—The Old Faith and the New: Dr. F. Strauss (Asher & Co.)—The Scholar's Arithmetic: Lewis Hensley (C. P. S. Macmillan & Co.).

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